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ABSTRACT

Papers presented by executives and administrators from all levels of education, and representatives from research, manufacturing, and commercial organizations, discuss relationships between modern technology and modern education, and educational data systems. Texts of presentations are included for: (1) 18 papers concerning computer applications to instructional support and curriculum in elementary and secondary education; (2) 15 papers on computer applications to instructional support and curriculum in post secondary and higher education; (3) seven papers in managing computers and computing--elementary and secondary education; (4) 11 papers in managing computers and computing--post secondary and higher education; (5) 14 papers covering information systems and applications--elementary and secondary education; (6) nine papers in information systems and applications to post secondary and higher education; and (7) six general interest papers. An author index is provided. (KP)

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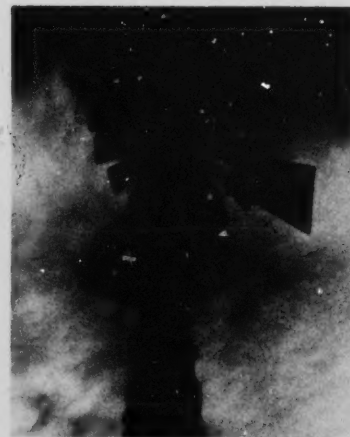
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PROCEEDINGS

15TH ANNUAL CONVENTION ASSOCIATION FOR EDUCATIONAL DATA SYSTEMS

April 25-29, 1977

Green Oaks Inn, Fort Worth, Texas



Educational Data Systems are a Function of Hardware,
Software, and Peopleware

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PREFACE

The Association for Educational Data Systems (AEDS) is a private, non-profit educational organization founded in 1962 by a group of professional educators and technical specialists in educational applications. Its intention is to provide a forum for the exchange of ideas and information about the relationship of modern technology to modern education.

AEDS membership is open to all persons interested in learning more and keeping informed about current developments and directions in educational data systems and computer technology. Included in the membership are educators and technical experts from all over the United States, Canada and other countries representing public and private schools, higher education, state and provincial departments of education, the federal government, the Armed Forces and other professional and technical groups interested in educational computer applications.

An annual international conference is held to bring together key people from education and technical specialties. Executives, administrators from all levels of education, and all types of research, manufacturing and commercial service organizations are represented at this conference. The convention committee for The 15th Annual AEDS Convention is very appreciative of the contributions made by authors of the papers printed in these proceedings. These papers provide a significant contribution to the body of knowledge about educational data systems. These papers and the exchange of ideas and information which takes place at the annual convention are very useful in helping professional educational systems persons support the educational goals and objectives of the institutions which they represent.

Additional copies of these proceedings may be purchased for ten dollars (\$10.00) from:

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The convention committee appreciates the leadership and support provided by the AEDS Board of Directors. Also greatly appreciated is the support received from Steve Raucher, through whom we received the IBM grant which made these proceedings possible.

Appreciation and commendation are in order for all members of the convention committee. Special thanks are also in order for Karen Lee and Lynn Britcher who spent many hours diligently handling records of the program committee and putting together the contents of these proceedings.

A. V. Majors
Convention Chairperson

Don Offerman
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INSTRUCTIONAL SUPPORT & CURRICULUM

Elementary / Secondary

A COMPARISON BETWEEN VARIOUS LEVELS OF INSTRUCTIONAL DESIGN
AND THE INTERACTIVE COMPUTER SYSTEM REQUIRED
TO DELIVER OR SUPPORT EACH LEVEL

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Decision points and basic information are discussed which should cause the planner to consider various alternatives or "trade-offs" relative to defining a computer system architecture which will meet instructional needs as opposed to dictating them. Terminology utilized, so far as possible, should be comprehensible by the school administrator or planner who is not necessarily familiar with computers.

1. INTRODUCTION

This study is an attempt at defining some basic information necessary for management level planning for instructional use of computers. In general terms, instructional theories are related to strategies (applications) in a task of teaching or learning, e.g., "work-oriented" process. In terms of that "work" taking place and the degree of individualization philosophy (such as many paths or one-path to same goal, etc.), principal decision points are examined in terms of what can be supported by or delivered by a computer.

Costs will not be addressed--only capabilities in general terms--so that instructional design can be the first (not the last) consideration. This is not intended to be a panacea to planning for instructional computing. It is an attempt to determine basic decision points applicable to instructional planning, performance considerations, and "trade-offs" necessary to generate a statement of strategies to be implemented by computer utilization in instruction. As R. J. Seidel stated "... there is no particular, absolute answer to the choice of hardware or the use of computers in education. A person, or institution, wishing to enter the field of computers in education must ask himself a number of questions and this is what I would like to discuss" (13, p. 2).

One assumption is made relative to this paper and the flow chart illustrating the entire process proposed by the study; both the target population and its learning needs would have been previously identified.

II. General Instructional Strategy: Individualization

The degree of individualization of instruction must be considered throughout planning for use of computer-based learning. Allegiance to a particular philosophy will have the effect of determining flexibility and room for planned growth of the

overall instructional system made up of computer, teachers, students, and other media.

The Air Force Advanced Instructional System (AIS) was the locus of a study to develop a model for individualizing instruction. The learning needs of the majority of students, course characteristics, and preassessment and reassessment during the course were among the factors addressed by McCombs and Siering to find a "decision model that can lead to the assignment of different instructional alternatives for students who may differ on a number of dimensions" (8, p. 9). Their concern was that the instructional system should meet the needs of students and identify strategies to yield intended results while reducing training time. Mizenko and Evans (10) in their work for the U. S. Army Training Center developed general guidelines for CAI which addressed provision of the most effective and efficient learning paths for both fast and slow learners. Particularly interesting is their exclusion of slow learners or those with no prior experience from pretest in order to avoid adverse effects upon motivation.

Decision Points

It is deemed to be more feasible at this point to describe in simple terms the various possibilities in individualization strategy so that the planner may address the ramifications for each as pertinent decision points are presented (17).

Modes of Individualization

Linear:	Fixed path to one goal
Mastery:	Varied time to one goal
Hierarchical:	Varied entry point to one goal
Random:	Varied sequence to one goal
Multi-modal:	Many paths to one goal
Multi-valent:	Individual goals and paths

It is entirely possible that many combinations of the above could be utilized. Implications for

computer support become readily apparent when the above (or some combination thereof) are profiled against any portion of the system. The user will perhaps find it necessary to return to many areas of this study before finalizing the general configuration, involving many relationships between theories, strategies, and delivery systems.

General Instructional Strategy: Other Factors

Consideration needs to be given to the independence or interdependence of computer-based instruction. Integral to this (regardless of the decision) is the utilization of the live instructor, aide, counselor, peer-proctor, etc. In order to apply learning theories to instructional strategies, a broad understanding of information requirements and of means available to optimize instructional control is necessary. Merrill and Wood discuss the specification of instructional strategy as "a recipe or blueprint for the construction of instructional materials:" (9).

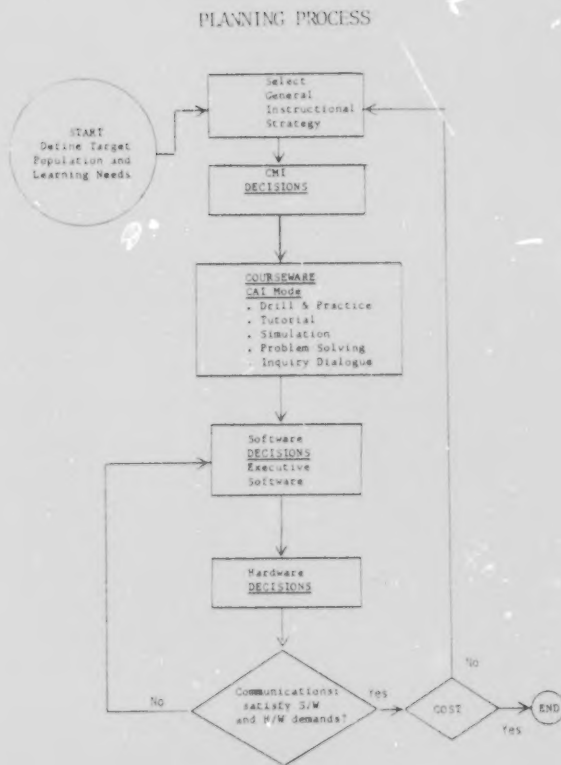
To be concerned with the individual, just how learning theories deal with his profile (capability for learning), must be questioned. Seidel proclaims that learning theories constitute a "description of an acquisition process" while instructional strategies constitute or refer to a "prescription for an acquisition process" (14, p. 5). Furthermore, to optimize that instructional strategy, resources are allocated in the control processes between the instructional agent and the student. The key to optimal allocation of learner controls in the process of instructional decision is to "(a) identify those components of strategy selection and use, of which students are capable, (b) relate these components to individual characteristics, and (c) determine where program control can or cannot manage the same components" (14, p. 7). Then, as a student moves through teaching/learning activities, his information-processing capabilities must be matched to the informational requirements of the learning tasks. Unlike "live" instruction, the control processes are able to take advantage of feedback from answers to produce a refined definition of a student's location in a course.

In instructional decision-making, the effects of strategies can be measured so long as they can be explicitly stated. Regardless of the media used, if the total teaching/learning process and the decision-making are included in the control processes, the effects of strategies can be measured so that the system, and hopefully the results, can be improved readily.

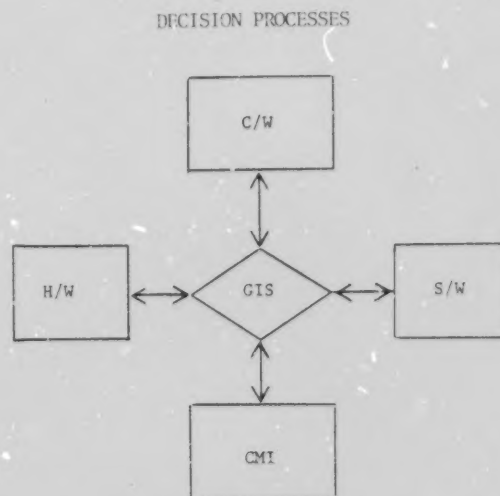
Pengov discussed development of a model of the student flow through the teaching/learning process and its application on a unit (instructional) basis. She sees the educational strategy and application of CAI materials as holding first priority over fancy hardware and computer systems. She states emphatically: "the model operates to meet the educational needs rather than to direct them" (11, p. 12).

III. TEACHING-LEARNING ACTIVITIES

A hierarchy of instructional strategy is implied



by the sequence of presentation within this section. This is done in terms of the complexity of activity on the part of the learner as well as the computer system, which is to imply that they are somewhat parallel: The decision chart below indicates the interface of key areas of concern with the General Instructional Strategy (GIS) for each mode of CAI.



Drill and Practice: This is a form of CAI generally construed to involve no new information transfer in its simplest form. Exercises are given the student for practice. These may be fixed, randomly-generated, tailor-made for each student, or in fixed or randomly-selected strands (6).

Decision Points:

Courseware

- . Randomly-generated functions
- . Randomly-selected questions
- . Control of sequence, time, difficulty
- . Use of strand concepts

Software

- . Programming languages
- . Storage (memory) size
- . Macros for authoring
- . Transfer and sharing
- . Number of users, programs
- . Response time
- . Executive
- . Documentation, monitoring for development
- . Type of answers facilitated
- . Time control

Computer Management of Instruction

- . Manage student activity in total curriculum
- . Testing, evaluation
- . Record-keeping, statistics, prediction
- . CMI for sophisticated modes of individualization
- . Strands
- . Use of live instructor
- . Batch reporting to teacher

Hardware

- . Number of users on line
- . Number of lessons on line
- . Response time
- . Time control
- . CPU, memory size
- . Hard copy terminal
- . Terminal design
- . Teacher monitor
- . Batch output
- . Stand-alone or network
- . Communications

Tutorial: This is a mode which may be used to introduce new information to the student and is generally construed to be an independent lesson.

Decision Points:

Courseware

- . Programmed instruction as design technique
- . Access to and from other modes of CAI
- . Amount of expository material affects run time economy: Look at terminal "write" speed and internal speed of CPU

Software

- . (See Drill and Practice)

Computer Management of Instruction

- . Record keeping, statistics
- . Diagnosis, prognosis, prescription
- . Manage total curriculum
- . CMI for sophisticated modes of individualization

Hardware

- . (See Drill and Practice)
- . Terminal "write" speed
- . Memory size

Simulation: A simulation program allows manipulation of a model of a real-life (or theoretical)

situation or process. It may relieve the student of tedious numerical work, expand or compress time, or permit the study of systems or experiments too expensive, massive, delicate, dangerous, or otherwise unavailable for practical utilization. Phillips (12) defines a model as being a characterization or representation of the actual situation. Two classifications of models are: iconic which looks like the real thing and analogous which functions like the real thing. The information necessary determines whether appearance, behavior, or some combination is of interest.

Decision Points:

Courseware

- . Modeling, writing programs
- . "Canned" programs

Software:

- . Language to write own simulations, make easy modifications
- . Support different types of hardware
- . Graphics? Interactive or passive?

Computer Management of Instruction

- . (See Drill and Practice)

Hardware

- . Stand-alone device or system
 - programmable calculator
 - intelligent terminal
 - minicomputer
- . Access to large CPU
- . Group display - TV connect?
- . Number of users, etc.
- . (See Drill and Practice)

Problem Solving: Whether the intent is study about the computer itself or as a device to be used in work or study, the student will program and otherwise control the system, which then may be utilized to manipulate data input by the student or, in some cases, to control or gather its own data from an experiment. In so doing, students learn to use the computer as a tool in the discipline they are studying. The computer may also be used as a tool to solve problems which could or would not be attempted in a classroom situation.

Decision Points:

Courseware:

- . Independent work: multi-modal, multi-valent
- . Students learn to program: tutorials on language(s)
- . Teacher capabilities in computer science

Software:

- . Language(s) necessary
- . (See and Drill and Practice)

Computer Management of Instruction

- . Manage studies on programming, test
- . (See Drill and Practice)

Hardware

- . Graphics?
- . Terminal design: characters or symbols for science or math
- . RJE devices including key punch or magnetic I/O for batch mode
- . (See Drill and Practice)

Inquiry (Dialogue): Inquiry (dialogue) is an interaction between the student and program, with either one asking and answering questions. The dialogue may be simply structured, with a highly

documented logic train, or a more sophisticated program which facilitates inquiry by the student in a "natural" language.

Decision Points:

Courseware

- . Talent to write and maintain programs
- . Adjunct or mainline studies?
- . Access to other CAI modes

Software

- . Memory, executive software to allow "natural" language use
- . Capability for access to other CAI modes
- . Access to problem-solving tools and techniques, etc.
- . (See Drill and Practice)

Computer Management of Instruction

- . Record student dialogue for development and modification
- . Tracking of individual progress toward objectives
- . Manage all instructional resources

Hardware

- . Additional computing power
- . Buffer storage in terminals
- . Communications
- . (See Drill and Practice)

IV. RESUME OF GENERAL COMPUTER CONSIDERATIONS

A. Software

Computer software is the set of instructions to the machine either given temporarily or permanently "installed" for control or operation of the system. Discussed here are six general categories of software which require management level decisions in the planning process:

- (1) Languages: sharing programs with other institutions is one way to keep CAI cost down. Languages must be available to meet the instructional philosophy to be implemented with computer use.
- (2) Programming: a policy decision needs to be made as to who is to program under what conditions or restrictions.
- (3) Executive-level Software: much as an executive manages, controls, and facilitates the operations of an organization, so does the executive level software perform similar functions for the computer system. A few of the executive functions of interest to the planner are:
 - . Monitor: examines new programs as they are being installed and points out errors in syntax or logic.
 - . Editor: facilitates modifications on existing programs
 - . Time: can control events on a time basis or report length of time between events (such as time required to respond; time as an accounting function for billing, etc.)
 - . Controlling the "traffic" in and out of storage. This affects speed (computer response time), branching distance which is feasible (e.g., a few lines in a lesson vs. to another lesson and back), and the number of simultaneous users.
 - . Specifying the "allowable" set of characters

(numbers, letters, special symbols).

Tracing the path(s) through actual operation of a program without taking the time for a normal run of that program--for "de-bugging" work.

(4) Computer Management of Instruction

The acronym CMI stands for Computer Managed Instruction. Its principal concerns are: diagnosis, prescription, and prognosis. The generally accepted connotation is that CMI "manages" student learning activities away from the computer. It may or may not include CAI in the light of being another medium or activity to be utilized. CAI is an instructional delivery system using the computer as the medium. Control of the study path through an instructional unit may be by the program in courseware, the student, or the teacher, according to the strategy and capability designed into the system. CMI can make it possible to evolve and maintain an organization for learning which is able to adapt to individual needs in a far more complex manner than can humans. Williams and Milner approached cost-effectiveness from the standpoint of evaluation of the total system, transferability of program, vigorous testing, and standardization of languages (18). CMI has the potential to furnish the data necessary for administrative decisions in those areas:

(5) General Software Considerations

A software consideration which has implication for instructional strategies, hardware, and executive-level software is the decision which needs to be made as to the degree of correctness which is acceptable for an answer. Structured answers (those with exactly specified numbers, letters, or string (character and/or number set)) are easy to program and require simple executive software. Approximate or "natural language" answers require that the answer to be scanned or compared to a list of possible answers. Simply stated, can the computer scan the answer for correctness, discriminate for generalities, and keep the instruction moving? The more flexibility desired, the more directly the instruction can be individualized, yet conversely are the requirements in storage, executive software and speed (of computer response) capability. According to Silvern, "Probably the most important software advance in the coming decade will be the use of macros... a book of strategies could be used by the INSTRUCTIONAL PROGRAMMER... just as a handbook is used by an engineer in designing" (15, p. 171). Dyer gives the definition: "Macro Instruction. A feature of many assembler programs (translates user input to machine instructions) which allows the programmer to generate predefined sequences of instructions in his program by simply writing one or more keywords" (2, p. 153). Kimberlin, in the Army Computer Assisted Instruction Project, gives a similar, but more detailed definition in which he lists five general types of macros developed for the instructional model: (1) those used for scoring, (2) emphasis (attention-getting), (3) pretest, (4) lesson review, and (5) special purpose macros. IBM in the "Interactive Training System General Information Manual," uses macros in the process of structuring a course. Realtime macros are used to generate

appropriate supporting macros (4).

(6) Courseware

Courseware is simply instructional software and has three key decision points to be considered: applicability to the needs of learners and instructional goals, transferability, and authoring. Effective remediation in the form of summaries and explanations can be provided to students whose performance is below standard. So can the powerful diagnostic capability of the computer be utilized to assess student achievement and to determine not only the specific weak areas and instruction required, but also the origin of the weakness. It is possible to have a flexible model with the capability to determine learning paths by on-line analysis of performance, historical data, predicted achievement, and based on realtime decisions. These same types of decisions apply equally as well to fast learners. Transferability means simply that an institution might wish to share programs with others or to utilize materials from other libraries. The best authors of courseware are, according to Luther in 1976, "full-time instructors who devote varying amounts of time to the preparation of content for CAI courses based on their own teaching material, subject knowledge and experience with the student "target" audience" (5, p. 22). He also looks at "full-time technical personnel with in-depth knowledge of computer operations, procedures, etc., but not necessarily with an instructional background," as good resource persons as well as "CAI staff members who research a problem, do task analysis and write course content." Luther maintains the position that only the CAI staff, not the author, should do the coding for programming. Among the reasons are: (1) the flexibility built into terminals should be exploited to avoid 'uninteresting' lessons, (2) instructors, carry full teaching loads and have little time available; whereas the CAI staff have the time and the skill, (3) the CAI staff wish to maintain the interest and enthusiasm of the instructors, and have the responsibility for producing quality materials in a reasonable timetable (5).

B. Hardware

(1) General System Considerations: Seidel talks about user requirements and facilities considerations as two categories of questions to be asked. He points out that the degree of control you wish to have over the technological base is relevant to the cost, availability, and priority of that system to you (13). One principal concern for the central system is the number of simultaneous users it can handle. Silvern states (15, p. 106): "To increase the number of LEARNERS which can be handled simultaneously, one must increase computer speed and storage." A system can be constructed on the concept of separation of authoring and time-shared delivery as a means of serving more learners (16). Even then, an "on-line" authoring system can be provided. Another configuration is predicated upon the concept of a central, powerful computer on a time-sharing concept serving a large number of users (numbering in the thousands) (1, p. 27). The need for a stand-alone instructional computer system can be eliminated by devising an interactive training system which uses a host computer and terminal(s) normally handling other transactions where the response time, storage and terminal

design are such that this is feasible (4, p. 1) (See macros in software section of this paper.) Hunter, Seidel, et. al., looked at the differences between a large central computer facility and the minicomputer (3, p. 285f). In general, the minicomputer user would elect to have the simple software in trade for the tremendous flexibility of a large system, communications costs notwithstanding. However, the report by Salisbury (see previous citation) indicates the differences in computing power (which translate in this case to memory and speed) are diminishing faster than educators are generally aware.

(2) Terminals: Generally there are two types of terminals: those which print and those which do not (CRT, graphics, audio-visual). The planner should consider noise, speed, and available character set from the user(student) viewpoint. System capability to "drive" the terminal at an acceptable speed and to function with required characters should be weighed in terms of the degree of individualization (e.g., complexity of programs). Reliability and maintenance factors require that the manufacturer or supplier be able to support the machinery with spare parts, supplies, manuals, and service. Time required to respond to a service request should be included as an important function of appraisal when selecting the computer system to be acquired.

(3) Communications: Communications links between terminals and computers have varying effects on costs and the technical level of a facility in areas such as speed of response, the type of equipment that may be used at a site, and what may be displayed to a user. "The design of a console is dictated by, and in turn dictates, the computer system design" (15, p. 164). In between the console and the computer are the communications, whether local, via a concentrator or controller, or over a distance via the modem and data channels. "The future of CAI has a financial base and the costs and limitations of cable and telephone cable subsystems will greatly influence what can be displayed to a LEARNER and how displays and responses may be stored and transmitted" (15, p. 107). Tariffs control not only the cost but also the technical level of performance of an installation, therefore, the CAI planner/manager will need to be aware of developments in FCC and Public Utility Commission rulings, legislation, and court decisions relative to tariffs. The communications industry has developed under regulation; the computer industry has been free from the rigueur of government control. The marriage of the two is not always achieved with students' benefits in minds.

VI. SUMMARY

The paper presented at this conference contains highlights of the rationale of the original study. Addressed in more detail in the original study are software, hardware, and management and personnel support areas related to delivery systems and key areas for decisions. For further information or to comment on the study, write to Robert A. Wright, Jr., Consultant, Texas Education Agency, Division of Instructional Resources, 201 East 11th Street, Austin, Texas 78701.

REFERENCES

1. Bitzer, Donald and Skaperdes, D., "The Economics of a Large-Scale Computer-based Education System: Plato IV" in Computer-Assisted Instruction, Testing, and Guidance, Edited by Holtzman, Wayne H., Harper & Row, 1970, pp. 17-29.
2. Dyer, Charles A. Preparing for Computer Assisted Instruction. Englewood Cliffs, New Jersey: Educational Technology Publications, Inc., 1972.
3. Hunter, Beverly; Kasner, Carol S.; Rabin, Martin L.; Seidel, Robert J., Learning Alternatives in U. S. Education: Where Student and Computer Meet. Englewood Cliffs, N. J.: Educational Technology Publications, 1975.
4. IBM, Program Product - Interactive Training System General Information Manual. IBM Corp., Technical Publications/Industry, White Plains, N. Y., 1973.
5. Luther, John P. CAI for EDP Operations Personnel the Second Year. Prepared for the October USE Conference, Orlando, Florida. U. S. Bureau of the Census, Washington, D. C., 1976.
6. Macken, Elizabeth and Suppes, Patrick, Evaluation Studies of CCC - Elementary-School Curriculums (Preliminary Draft). Palo Alto, Ca.: Computer Curriculum Corporation, 1971-75.
7. Martin, James, Design of Man-Computer Dialogues. Englewood Cliffs, N. J.: Prentice-Hall, 1973.
8. McCombs, Barbara L. and Siering, George D. of McDonnell Douglas Corporation, St. Louis, Mo. Work Performed Under AF Contract F33615-73-C-4404 to: Technical Training Division, Air Force Human Resources Research Laboratory, Lowry AFB Colorado. The Design and Development of an Adaptive Model for the Air Force Advanced Instructional System. Sixth Congress of the International Ergonomics Association, Washington, D. C., 11-16, July 1976.
9. Merrill, M., David and Wood, Norman D. "An Instructional Strategy Taxonomy: Theory and Applications." Journal for Research in Mathematics Education, pp. 195-201, November 1975.
10. Mizenko, Albert J. and Evans, Allyn A. An Instructional Model for Computer Assisted Instruction. Technical Report 71-2, U. S. Army Signal Center and School, Fort Monmouth, N. J., May 1971.
11. Pengov, Ruann E. "Final Report on Development of Medium and Long Range Plans for Improving United States Army Training." The Future of the Computer in Army Training. Final Report. Computerized Training Systems Project. Fort Monmouth, N. J., February 1975.
12. Phillips, Jr., Steve, "Systems Modeling Simulation Games," A Systems Approach to Learning Environments. Meded Projects, Inc., 1975.
13. Seidel, R. J. Hardware Technology for Computers in Education: One of the Soluble Problems. Human Resources Research Organization, Alexandria, Va., May 1974.
14. Seidel, Robert J., Theories and Strategies Related to Measurement in Individualized Instruction. Human Resources Research Organization, Alexandria, Va., March 1971.
15. Silvern, Leonard C. Systems Engineering of Education VI: Principles of Computer-Assisted Instruction Systems. Education and Training Consultants Co., Los Angeles, Ca., 1970.
16. The MITRE Corporation, An Overview of the TICCIT Program, McLean, Virginia, January 1974.
17. Walberg, Herberted; Talmage, Harriet; Rippey, Robert M.; Eash, Maurice J. Educational Products Information Exchange Institute, Evaluating "Individualized" Materials, Educational Product Report - An In-depth Report, Number 46, New York, October 1972.
18. Williams, Mary Carter and Milner, Stuart D. "The Attitudes of Medical School Administrators Toward Cost Factors Relating to Computer-Assisted Instruction." Journal of Computer-Based Instruction, Vol. 2, Number 4, pp. 83-94. Association for the Development of Computer-Based Instructional Systems, Los Angeles, Ca., May 1976.

A COMPUTER-SUPPORTED MANAGEMENT SYSTEM FOR INDIVIDUALIZED READING

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Charleston SC Public Schools
Steven F. Watts
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Charleston County School District has developed a program which utilizes data processing technology to assist teachers in managing their classroom reading efforts. The program is one of 45 innovative programs selected for inclusion in the nationwide HEW Study of Sustaining Effects.

INTRODUCTION

Reading is a complex process that eludes uniform definition among the experts. It certainly encompasses the recognition of words by meaning and pronunciation and the comprehension of concepts created by the relationship of words to each other. In order to teach reading, a classroom teacher must have verbal command of the technical processes of reading. Effective results, however, also depend upon the teacher's skill at classroom management.

The Charleston County School District is utilizing computer technology in a program to assist the classroom teachers with many of their management responsibilities. From conception, the developers of the system were operating under several pre-established requirements:

1. The system would be designed as a practical workable aid to classroom management. This requirement meant that the teacher would receive only information pertinent to the instruction taking place in that particular classroom; i.e., the teacher is not bombarded with vast amounts of "hard to understand" statistical data.

2. The system would have to operate on the school district's existing equipment configuration, and to the extent practical, the software would be developed in a higher level computer programming language.

CLASSROOM MANAGEMENT TASKS

Management tasks of the teacher are the following: (Figure 1)

1. Assign each student to a reading text in which he can recognize 95 percent of

the words and comprehend 75 percent of the concepts.

2. Identify the specific objectives or skills each student has learned and those objectives to be taught next.

3. Assign students with the same skill needs to groups.

4. Select instructional materials to teach the needed skills to each student or group.

5. Plan and provide instruction for each student through verbal interaction.

6. Assign and check practice work for each student.

7. Identify students that have mastered the selected skills and plan for instruction on new skills.

8. Identify students that have not mastered the selected skills and plan supplemental instruction.

To provide help with classroom management, Charleston County School District has designed a reading program that has computer support for tasks 1, 2, 3, 7 and 8. The entire program is called the Continuous Progress Reading Program; the name was derived from a district commitment to provide successful learning experiences for each student at the most rapid pace possible even though in the early stages of implementation the program was used only with the lowest achieving elementary students.

CONTINUOUS PROGRESS READING PROGRAM

The Continuous Progress Program utilizes criterion-referenced tests to assess objective mastery for each student. The tests contain three items per objective with the criterion for mastery set at 100 percent. The tests are computer scored and teachers receive three kinds of printouts: an objectives mastery report; a class grouping report; a student status report.

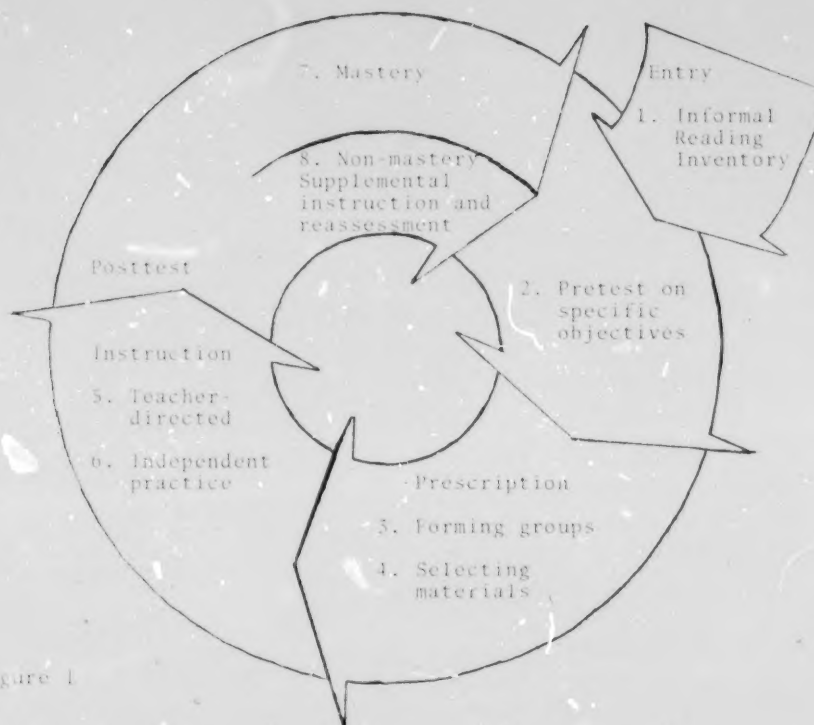


Figure 1

COMPUTER PREPARED REPORTS

The Objective Mastery Report (see Figure 2) is a class printout that identifies specific objectives each student has mastered--Management Task 2. It includes a "+" or a "-" indicator for each test item as well as an asterisk to indicate objective mastery. An "o" indicates that the student has omitted the test item. This omission may be an inadvertent behavior on the part of the student. It may occur

at the teacher's direction, either because the teacher already knows from classroom evidence that the student cannot perform the task or because in her observation of the testing process she sees that a student is reaching a point of complexity in the task hierarchy that is causing multiple errors and undue frustration. If omission or error indicators appear under the test item number, the mastery column remains vacant. Percentage of mastery information is given by student and by objective.

SANDERS, CLYDE

CHARLESTON COUNTY CONTINUOUS PROGRESS PROGRAM OBJECTIVE MASTERY REPORT READING

01/12/77 PAGE 1

WORD ATTACK 001571 1

GRADE 4	JOHNSON CLARA N	07281	WA7.1	WA9	WA1.1	WA1.2	WA1.3	WA1.4	WA3	WA4.1	WA10.2	WA11.1	WA11.2	WA1.1	WA1.2
		1 2 3 M	4 5 6 M	7 8 9 M	10 11 12 M	13 14 15 M	16 17 18 M	19 20 21 M	22 23 24 M	25 26 M	27 28 29 M	30 31 32 M	33 34 35 M	36 37 38 39 M	40 41 42 M
0016372	BROWN JOAN A	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0017814	JACKSON FORREST T	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0014326	KNIGHT ANNA B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0013761	WASHINGTON NATHANIAL R	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0017412	JONES RODES	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0019041	PAULWAY FRANCIS	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0016772	ADAMS JONATHAN O	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0017423	BENNET TIMOTHY F	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PERCENT OF STUDENTS HAD MASTERY		88	92	88	8	84	72	60	80	38	32	20			

Figure 2

GRADE 4	JOHNSON CLARA N	07281	STUDENTS NOT MASTERING		BASAL	WORD ATTACK I
						001571
WA7.1	INITIAL CONSONANTS		0014326	KNIGHT ANNA B	11	EXPLORING
			0013761	WASHINGTON NATHANIAL R	11	EXPLORING
			0017412	JONES ROBERT P	12	BLASTING A
WA9	FINAL CONSONANTS		0013761	WASHINGTON NATHANIAL R	11	EXPLORING A
			0017412	JONES ROBERT P	12	BLASTING OFF
WA1.1	INITIAL CONSONANT BLENDS (FR DR PR)		0017614	JACKSON FORREST T	11	EXPLORING AFA
			0014326	KNIGHT ANNA B	11	EXPLORING AFA
			0013761	WASHINGTON NATHANIAL R	11	EXPLORING AF
			0017412	JONES ROBERT P	12	BLASTING OFF
			0019041	PAULEY THOMAS D	12	BLASTING OFF

Figure 3

The Class Grouping Report (see Figure 3) lists each objective receiving a non-mastery indicator by any student in the class, and, under that objective, all students who showed a lack of mastery. In this way, Management Task 3 is handled with computer support. Although Management Task 1 must be performed by direct teacher involvement, the basal readers assigned to the students are printed out on the Class Grouping Report as they are necessary to the performance of Management Task 4 which receives no other computer support currently.

The completion of Management Task 4--the selection of instructional materials for each student--is contingent upon several factors: What material does this teacher have available? What material does she prefer? Does this student learn better through a visual, aural, or kinesthetic approach? Which material contains concepts more closely aligned to the student's experiential background? Which material contains concepts supportive of social studies or science concepts? Which material can best be used in a peer tutoring arrangement or in a pupil team organization or in a self-instructional format?

The answers to these questions can most appropriately be supplied by the classroom teacher. Forty reading instructional materials have been selected and correlated to the reading objectives by Charleston County School District personnel. The materials were selected on the basis of their instructional objectives, classroom manageability, low recurring costs, and their appeal to teachers and students. During the summer, classroom teachers correlated the reading objectives to the specific pages, tapes or cards of the instructional materials. The criterion was established that no page, tape or card would be coded unless at least 50 per-

cent of it covered instruction on the specific objective. Pages, cards or tapes listed for two separate objectives were denoted by an asterisk.

In Title I schools, instruction for the student occurs in the regular classroom and, for the slowest students or those with temporary problems, in a special lab. Instruction is conducted by the regular classroom teacher and by a coordinating teacher with support from an aide. In non-Title I schools all instruction is conducted in the classroom by the regular classroom teacher.

After instruction, posttesting with computer scoring results in the information necessary for the teacher to complete Management Tasks 7 and 8. Again, the Objectives Mastery Report and the Class Grouping Report are produced for the teacher, and the cycle begins again at Management Task 3.

The last computer printout a teacher receives is the Student Status Report (see Figure 4). This printout is the only individual student record produced. It is used to summarize the student's performance over a designated period of time; add information to the cumulative folder; give information to parents. Under "You Were Able to Master" would be listed objectives on which the student demonstrated mastery the last time he was tested over them; that is, if the student for some reason demonstrated mastery on objective WA7 on the pretest but not on the posttest, objective WA7 would not be listed under "You Were Able to Master."

For the permanent record the Student Status Report carries the name of all basals the student has been assigned in his current school year. Since this report is produced by student by test, the percentage of objectives with mastery indicators at each testing is given.

07281

BROWN JOAN A

0016372

WORD ATTACK 001571 I

YOU WERE ABLE TO MASTER		BASALS	
WA7.1	INITIAL CONSONANT	10	DISCOVERING TREASURE
WA9	FINAL CONSONANT	11	EXPLORING AFAR
WA1.1	INITIAL CONSONANT BLENDS (FR, BR, PR)		
WA1.2	INITIAL CONSONANT BLENDS (FL, GL, SL)		
WA1.3	INITIAL CONSONANT BLENDS (SM, SN, SK)		
YOU NEED TO LEARN HOW TO			
WA1.4	INITIAL CONSONANT BLENDS (SW, SP, SK)		
WA3	FINAL CONSONANT BLENDS		
WA4.1	INITIAL CONSONANT DIGRAPHS		

RATIO OF OBJECTIVES MASTERED TO OBJECTIVES ATTEMPTED 5 OUT OF 11

Figure 4

HARDWARE REQUIREMENTS

The system is currently operating on an NCR Century 101 computer with a 32K processor. Input is through a magnetic tape interface built into a key-to-tape station. All of the required data files are located on one disk pack.

Charleston County originally utilized an OpScan 17 for test scoring. This equipment has been replaced with an NCS 10 scanner. The programs are designed to operate in either environment.

SOFTWARE

The computer programs supporting the Continuous Progress Program are written in COBOL. Design considerations were given to certain areas to make the system as hardware independent as possible without degrading the overall system performance. For example, standard answer sheets are used for all tests. This gives the program managers freedom to add or modify tests without requiring computer program modifications.

Overall the software is relatively straightforward. It provides the basic reports necessary to support the Continuous Progress Program but is flexible enough to allow expansion as the county data processing capabilities grow.

FINDINGS AND RESULTS

The integration of computer technology into the classroom has proven to be very successful in the Charleston County School District. A survey of all teachers involved in the first phase of the project revealed 97 percent acceptance and use of the information provided by the program.

While primary objective of the computer support for the program was to provide management information for the teachers, the developers were also aware of the overall project information which would be available. For example, a normative evaluation of the slow and below average readers in the program for the school year 1975-76 shows a percentile gain above and beyond the normal rate of learning although this kind of student normally learns slower than the normal rate. The gains above and beyond the normal rate ranged from nine percentile points at the second grade level to three percentile points at the fifth grade level. This analysis followed a 1974-75 analysis that showed similar students at grades two and four gaining in excess of five percentile points above and beyond the normal learning rate.

A DATA BANKING SYSTEM FOR STATE OPERATED
CRITERION-REFERENCED TESTING PROGRAMS

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Center for Evaluation and Research
Rhode Island College

With greater acceptance of criterion-referenced testing more state departments of education are developing CRT programs as a normal component of statewide assessment activities and/or as a service to local school districts. The Center for Evaluation and Research at Rhode Island College recently designed a data banking system for the Rhode Island Department of Education which will provide the local districts with a means for conducting criterion-referenced testing operations both in the classroom by the individual teacher and at the district-wide level.

Under contract from the Rhode Island Department of Education (RIDE), the Center for Evaluation and Research at Rhode Island College (CERRIC) recently completed a feasibility study in which it designed a criterion-referenced, instructional objective and test item banking system. The system will be financed by RIDE and administered by a contractor for the benefit of all state school districts participating in RIDE's Local Planning and Assessment Process (LPAP). According to the recommendations of the study, this banking service will be developed within the first year of funding and operated at two different levels thereafter. Individual classroom teachers will have a means of accessing the objective and item banks for use continually throughout the school year, and a RIDE employed contractor will operate a test construction and scoring facility for each school district in the LPAP program to conduct a district-wide assessment.

LPAP is intended by RIDE as a long-term process aimed at enabling the local school systems to relate their instructional programs to the needs of their communities and thus enhance their accountability procedures. Similar to the planning and evaluation phases of most PPBS models, LPAP is a cyclical process consisting of five components. In the first, the Local Educational Agency (LEA) or local school system must establish an educational philosophy and derive from it a comprehensive set of goals. Secondly, the LEA will survey the community to determine educational needs and priorities. In the third component, the LEA will analyze both existing and proposed programs which address those priorities and develop a comprehensive plan. The fourth compo-

nent consists of implementing that plan. In the fifth, the LEA will perform formative and summative evaluations of its progress in meeting that plan's objectives. The banking services proposed by CERRIC in the feasibility study will primarily be directed at validating the educational needs determined by the survey and at evaluating the success of meeting the objectives of the comprehensive plan. Of course, in addition to these curriculum planning functions the objectives and test items can also be employed for classroom instructional purposes.

In designing this banking system CERRIC realized that there are two overriding concerns which had to be taken into account no matter what particular specifications might be involved. First of all, each component of the system had to be selected, implemented, operated, and/or evaluated by individuals with sufficient technical expertise to insure quality. But secondly, because the banking system is intended for local school district use, it could not appear as "just another program promulgated by the state department on the locals." Rather the system had to be judged truly as a RIDE service for the LEA's. Thus, for the development phase CERRIC sought to design into the specifications extensive involvement not only from the employed contractor but also from education specialists at the state's colleges and especially from administrators and teachers in each of the participating school districts.

One of the initial tasks in the development of the banking system was the determination of the bank's contents. Because so many organizations have marketed instructional behavioral objectives writ-

ten for the classroom level within the past several years, CERRIC recommended that RIDE not develop these objectives from scratch. Rather the resources of the larger, more comprehensive objective collections should be purchased, and from these the specific contents of the RIDE banks should be selected. This method will save both time and money, and if test items are included with the objectives in these collections, then the procedure will guarantee the existence of already field-tested items. Among the organizations CERRIC recommended are the Instructional Objectives Exchange at UCLA, the Institute of Educational Research in Downers Grove, Illinois, the Objectives and Items Co-op at Amherst, Massachusetts, and the Tri-Country Goal Development Project, of Portland, Oregon.

CERRIC recommended that RIDE's banks cover fourteen curricular areas ranging from reading and mathematics to bilingual education and special education. Although specific objectives will not be directed at a particular grade level, the needs of all grades K-12 should be served with objectives that demand comprehension, analysis, and evaluation skills. Within each curricular area the number of objectives for inclusion will vary from 300 to 1500 depending on the diversity of that area. Surely, many more can easily be added, but with excessively filled banks there is the strong probability that many objectives will remain unused for years. In addition to the curricular areas, CERRIC recommended that objectives for affective areas such as attitude toward school and attitude toward self be developed and that objectives without test items covering the student's learning environment also be written into the banking system.

To insure the technical quality of the product and to encourage acceptance of it by the LEA's, CERRIC thought that the actual selection and/or writing of the objectives and items should be managed by small committees composed of representatives from the contractor, school curriculum specialists from the state's colleges, administrators and teachers from the local school districts, and program coordinators from RIDE. Committees for each curricular area of less than ten members in number would be charged with the task of determining the bank's overall contents. CERRIC presumed that the contractor to be employed will be fully experienced in objective and item development; nevertheless, included in the final report were extensive criteria to aid in the process of bank development via committees of educators. Moreover, it was decided that at least eight to ten test items per objective should be selected. Since all objectives and test items will also be released by RIDE to the local school systems, test security for the district-

wide assessment will be compromised. Yet the relatively large number of items per objective and fairly comprehensive banks will assure that an adequate degree of security can be maintained.

Once the contents of the banks have been established by the committees, then the contractor will have three major tasks remaining to complete the development phase. First, each objective and test item will have to be appropriately coded to identify its relationship to such matters as the overall curricular area and the subdivision thereof, one of the cognitive, psychomotor, or affective domains, one of the seven Rhode Island Board of Regents' goal areas (e.g., personal, aesthetic, social,...), one of the skills categories designated by RIDE (i.e., comprehension, analysis, and evaluation), and the probable grade level range. For example, $2x + 4 = 8$ might be catalogued as 05842C214. This number will translate to state: mathematics (05), algebra I (8), objective (42), cognitive domain (C), Regents' goal: personal (2), skill: comprehension (1), and grades 7-9 (4).

The second major task remaining will be the printing of a sufficient number of booklets, containing all the objectives and test items for each curricular area, for dissemination to each school building in the communities participating in LPAP. CERRIC recommended that no more than two sets of booklets be delivered to each building. These booklets will have two main functions: (1) they will provide every classroom teacher with the resources for developing his/her own criterion-referenced testing program, and (2) they will provide the informational means for accessing the contractor who will conduct the district-wide assessment operation.

Finally, the development contractor will be obliged to put together the physical components of a paper-based test construction system. Because of the extraordinary start-up expenses, the lack of flexibility, and the lack or incompatibility of access hardware within the local school districts, RIDE elected not to operate a central computerized test construction facility. This paper-based file system will simply consist of master pages of objectives and items suitably coded, an index card system identifying objectives only, answer guides for the items, and file cabinets for housing the entire collection. Although assembled by the development contractor, the paper-based test construction system is intended to be managed by the personnel of the contractor conducting the district-wide testing operation.

With the completion of the development phase of the banking system, the first of the two operational phases, data bank utilization at the local level, will be ready for implementation. Employing the objective and test item banks within the

local districts places the actual operational responsibilities on the individual teacher who could use these materials as often as he wishes during the school year. The basic method of operation will be rather simple: a teacher obtains the booklet of objectives and test items covering his curricular area from his principal, guidance counselor, or whoever maintains custody, selects the objectives he desires to employ over a certain period of time, teaches to these objectives, re-obtains the booklet and selects appropriate test items, constructs and administers a test, establishes mastery levels and scores the tests, and then determines from the results what successes have been achieved in student learning. If the teacher were to integrate such a measurement system continually but subtly into his overall teaching plan throughout the school year, then he would be instructing in a most beneficial manner, for he would be testing on what he teaches and not teaching for a pre-determined test.

Criterion-referenced testing at the local level, however, is not without potential problems. Lack of experience in test construction among teachers may effect invalid instruments, teachers' unions may consider participation in this process as an activity beyond the normal duties of their members, and tests may be intentionally structured to demonstrate considerable student competence and thus satisfy local political pressures for greater achievement in a particular school building or district. Consequently, CERRIC recommended that RIDE institute a number of governance and reporting procedures for the local districts. Primary among these are ones requiring the establishment of definitive accountability policies at the local level and the establishment of a data bank usage reporting procedure so that a measurement of the banking system's impact on the IEA's can be ascertained.

The other component of the operational phase of the banking system, that which requires a contractor to manage a facility performing district-wide assessment, will not be implementable immediately. Set-up and time to develop the necessary computer programming will delay its start up to one year. Mainly, the functions of this facility are directed at offering a given school district the opportunity to conduct some type of overall assessment of the success in meeting specific instructional objectives in, for example, American history at the fourth grade level or high school chemistry. CRT instruments constructed by the contractor for this assessment can be directed at all students within a selected grade or just a sampled population of the school district.

Via the booklets of objectives and items printed by the development contractor, the LPAP districts will have rather

easy access to the operations contractor. The LEA administrator responsible for devising the district-wide assessment plan will select which objectives he wishes to cover on the test, list them by their coded identification numbers on an appropriate form, and mail or deliver that form to the contractor. Once the form is received, it will be immediately checked for flagrant errors. If there are none, the objective codes will be input to the computer which would randomly generate four or five test item code numbers corresponding to each objective. After being checked for accuracy, this printout will be delivered to a paraprofessional who will operate the paper-based test construction system. Retrieving the items from the master pages, this paraprofessional will then type up a test, making sure to keep the items in the same randomly arranged order. With this system and with the responsibility for test duplication retained by the local district, a two- or three-day turnaround time for test construction is fully possible.

Among other obligations of the operations contractor will be the management of in-service training workshops for all participating school districts. Teachers inexperienced with CRT will inevitably fear the possibility of greater accountability and may not be inclined to employ the bank's services at all. Administrators as well may have to be shown the benefits for curriculum planning that this assessment service can offer.

Moreover, the operations contractor will have to develop the computer software for a variety of tasks. These will include the storage of the identification codes for the objectives and items, the random generation of items for selected objectives, the maintenance of an item use history, the regulation of the answer sheet scoring operation via a mark page optical reader, the maintenance of test performance records for individual students, schools, and districts, the preparation of statistical reports and item analyses on the test results, and the maintenance of all data for eventual inclusion in the update and revision processes.

In addition, because of a need for update and revision, a questionnaire to evaluate the utility and effectiveness of the overall banking system will be developed. Among concerns to be scrutinized in this instrument are such matters as quality and quantity of the bank contents, value of the test result reports and item analyses, and usefulness of the overall system for curriculum planning and classroom instruction. Finally, CERRIC recommended the establishment of an on-going update and revision committee which will meet periodically throughout the year to review the progress of the system, change or modify minor component functions, and

advocate the adoption of major alterations when deemed necessary. Like the bank development committees, it will also be composed of representatives from RIDE, the education departments of state colleges, the local school districts, and the contractor.

One last recommendation of CERRIC's feasibility study advocated that all data acquired through the banking system proposed for LPAP be included in RIDE's Management Information System (MIS). Still in its formative stages, MIS will provide for RIDE a data collection "clearing house," storing information of statewide activities for purposes of control, management, and planning.

A REGIONAL DELIVERY SYSTEM FOR
COMPUTER ASSISTED INSTRUCTION PROGRAMS

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This paper describes a delivery system for providing computer assisted instruction (CAI) services to a school district network of 31 remote job entry terminals, 14 minicomputers, and 469 instructional terminals. These are linked by communication to a central processing unit consisting of twin Cyber 172s.

Region IV Education Service Center is an intermediate state agency that provides a wide variety of educational services to school districts in the Greater Houston area. As one of three Multi-Regional Processing Centers (MRPC) established to meet the computing needs of Texas school districts, the Gulf Texas MRPC serves 101 districts in the Houston area.

The main advantage of this regional delivery system lies in the fact that the Service Center is able to offer a wide variety of services to a large number of school districts at a reduced cost. A regional computer system provides for more flexibility because of the savings in both human and financial resources. Because of the support a regional service center provides, school districts can more readily adopt a technological innovation like CAI. Districts can contract for a single CAI program or a combination of programs available in drill and practice, tutorial, dialogue and simulation modes. After hiring their own management staffs, Region IV can help the districts overcome the common obstacles encountered in initiating and evaluating a new program.

Though most educators recognize the potential of the computer for individualizing instruction, there is still considerable resistance to computer assisted instruction. Many contend that the computer dehumanizes education. Some are afraid that the computer will become a surrogate instructor capable of replacing the classroom teacher. Despite these objections, the value of computer assisted instruction has been recognized by participating schools in Region IV and acceptance of CAI programs appears to be growing every day. Most reviewers have found that CAI can accomplish the

instructional goals presented through more traditional methods in less time. Research on the effectiveness of CAI in raising achievement levels of Title I students has been documented through the use of several standardized instruments, yet the success of any project is more than raised achievement scores. Teachers and administrators must be able to recognize the benefits of CAI if it is to have any real impact on the educational establishment and this is where the Service Center can provide assistance. Region IV plays a key role in preparing district staff members for CAI implementation and helps them integrate its use with other existing programs.

There are numerous ways in which Region IV can provide support to school districts that want to implement CAI programs. While the Education Service Center provides technical assistance with installation and maintenance of both hardware and software, the effectiveness of any new program hinges on the attitudes of the people who are responsible for working with it. A continuous inservice program is therefore provided for administrators, teachers and support staff. Consultant assistance is provided to help teachers make use of computer generated reports in their instructional planning. The compatibility of the CAI programs with existing curriculum objectives is explored along with other considerations such as scheduling, staffing, evaluation, and management.

The role of Region IV, like that of most intermediate state agencies, is oriented more towards the dissemination of services than toward development. There are a few areas, however, where product development must be undertaken in order to promote the successful diffusion of an innovation

like computer assisted instruction. Region IV has made a concerted effort to develop staff training products such as slide/tape presentations, transparencies, training modules, and handbooks so local administrators and curriculum specialists can assume a leadership role in training their own staffs. Informational brochures and other awareness materials have also been developed and disseminated to inform educators about the use of the computer as a tool for instruction.

School districts also receive assistance from Region IV in evaluating their CAI programs. One of the most frequently noted problems identified in the literature on CAI is the lack of data documenting the effectiveness of CAI applications. Schools served by Region IV receive a statistical analysis of student achievement gains on a quarterly basis. Administrators are provided with mean achievement gains and a variety of cross tabulation reports to help them monitor the progress of their students. Management reports have also been developed for the drill and practice programs. These reports alert teachers to the names of students not making expected progress and pinpoint specific "trouble spots" that individual students may be having in certain skill areas. This kind of information helps facilitate flexible skill grouping for the purposes of instructional management. Other products communicate information to parents and teachers about student progress. Certificates of progress and certificates of participation can be produced for individual students to report the amount of gain each student has made in the CAI program.

The use of computer assisted instruction programs can be a tremendous boon to the individualization of instruction. CAI often fosters a greater accommodation for individual differences, and some of the drill and practice programs available promote accountability while providing for diagnostic prescriptive instruction as well. For example, many of the districts in Region IV use Suppes' CAI drill and practice programs for supplementary instruction in the basic skill areas of reading, math, and language arts. Although most of this curriculum is designed for use in the elementary grades, there are a number of intermediate, junior and senior schools using the programs for remedial instruction. The majority use this computerized curriculum to supplement, not supplant, the developmental instruction offered in the classroom. The program is set up on an individualized basis so each student is working at his own instructional level. The student's interaction on the

terminal provides for diagnostic prescriptive instruction. The computer actually helps pinpoint skill deficiencies. The student is first enrolled on the computer at a grade level based on his teacher's judgment. The teacher decides on the composite level of functioning by taking into consideration each student's standardized test scores as well as his past and present performance. After ten lessons the computer refines the teacher's diagnosis by pinpointing the student's level of performance in each subskill area. Assessment is ongoing in that the computer continuously evaluates performance. This instantaneous feedback promotes learning since the student does not have to wait until his paper is graded to find out if his answers are right or wrong. Each student gets the kinds of practice exercises he needs, yet is allowed to proceed at his own pace.

While it may be several years before mass implementation of CAI becomes a reality, planning should begin now. In implementing any new innovation there must be some consideration given to adapting it to needs of the user if it is to be integrated into a school's operating system. Computers have the potential for making a significant impact on the educational establishment and an intermediate state agency can help promote this development.

AN INTERACTIVE SOFTWARE SYSTEM
FOR COMPUTER-ASSISTED TESTING

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Studies

This paper describes an interactive computer software system developed at Tuskegee Institute which is designed to allow flexibility in the development, administration and scoring of examinations. TICAT (Tuskegee Institute Computer-Assisted Tester) is written in a version of Time-Shared BASIC and is currently operational on the Hewlett-Packard 2000-ACCESS system. It is designed to be used by persons without knowledge in either computer programming or computer operations. TICAT is composed of a set of computer programs which are "chained" to one another. The software performs the functions of (1) developing computer resident exam item files, (2) creating and administering examinations, and (3) generating examination scores and reports on over-all examination performance. TICAT also makes provision for securing the files against theft.

While computers have been used for many years to assist teachers in the scoring of examinations, until fairly recently they have not been generally employed by classroom teachers for the tasks of developing, maintaining, generating and evaluating examinations. It should be noted that these tasks have been routinely performed by the computer for specialized testing services, such as those who market aptitude and placement tests. These organizations have been able to employ the technical staffs necessary to supply the computer software that performs these tasks. On the other hand, the classroom teacher who has had computer services available to him or her and who has been adventurous enough to use it has been typically limited to a "canned" program which used either data cards or sheets as input and supplied test scores and sometimes some sort of statistical analysis concerning over-all class performance and even possibly an item analysis. In this situation, the computer has served as a tool only after the exam was given. It did not play a role in the development of the examination and could only play a limited role in future revisions.

There are several reasons for this situation. First, very few teachers at the primary, secondary, or college level are computer programmers. They are not expected to be programmers. They were hired to teach English, physics, history, etc. Most have neither the time nor the inclination to learn programming. However, this has meant that the teacher has had to confront the computer via a technician and

this has neither been desirable nor for that matter always possible. The development of an examination is very often a personal thing with teachers. For security and other reasons they tend not to share the task with others. The exception being that they often have a trusted secretary to type the final version and to secure it against theft. Furthermore, academic computing centers have typically lacked the personnel to supply specialized services to large numbers of teachers. In addition, until the last few years computer systems have been mostly batch operations and teachers and other users have had to depend on computer center staffs to make certain that jobs were run and output guarded and returned. There was a real physical as well as psychological distance between the user and the computer. Computer users who were initiated to programming a decade or so ago remember the uncomfortable feeling of leaving a deck of cards (input) in some box or window outside the computer room and then coming back a day or so later (slow turn around time) for output. One had only the vaguest notion as to what was going on with his or her precious input. Some other person or persons were handling it. Needless to say this sort of feeling is not the type that would encourage teachers to use the computer for the development of examinations.

Computer Time-Sharing

With the advent of time-shared computer systems with interactive languages many of the problems associated with the use of the computer for the construction of examinations are being solved. Software is

being developed which allows the user to interact with the computer with English language commands. The teacher no longer has to deal with the computer center staff in order to use the computer. Furthermore, with on-line file storage and an adequate security system the user is discovering that the computer is a safe place to keep examination items and other sensitive materials. Thus, one of the major tasks confronting personnel in academic computing is the development of interactive software systems that will allow teachers and other educators who lack computer knowledge easy access to sophisticated software systems which will enhance the educational program.

Computing at Tuskegee

Tuskegee Institute has had a time-shared computer system for the past five years and during that time there has been an exponential increase in the use of the computer by the faculty. Much of this increase has been in response to the development of interactive software that assumes that the user is not familiar with the operation of a computer. Tuskegee has computer terminals in most of the academic departments on campus. These terminals provide teachers and students with easy access to the computer. Increasingly, both students and teachers are using the computer in their work.

The Development of TICAT

This paper describes an interactive computer software system which the author has developed at Tuskegee Institute which is designed to allow non-computer types a great deal of flexibility in the use of the computer for the development and administration of objective-type examinations. The system is called TICAT (Tuskegee Institute Computer-Assisted Tester) and is written in a version of Time-Shared BASIC currently operational on the Hewlett-Packard 2000-ACCESS system. It was written to be used by persons without any computer knowledge.

TICAT is composed of a set of over a dozen separate programs that are "chained" to one another. There are three distinct functions performed by the software:

1. The development of exam item files;
2. The creation and/or administration of examinations;
3. The performance of exam scoring, record keeping and report generation tasks.

Obviously, the functions are not independent of one another. Exam item files must be created before examinations can be created, and examinations must be administered prior to scoring and report generation.

After logging on the system, the user calls one of the three main programs associated with the TICAT systems and executes it. From then on, the computer supplies the user prompts in the form of questions. The user need only to respond to these questions with English language commands of one word in length. An attempt has been made to make the programs fool-proof so that if the user requests a task from the system that is not possible the user is informed that the task is not possible and is asked to supply another command. Also, the author attempted to make the system fool-proof by building in checks that make it extremely difficult for the user to inadvertently destroy the contents of a file or to destroy the proper structure of the file. One of the primary concerns of the author was to design a system that could be used by the teacher without having to depend on computer center personnel.

Development of Exam Item Files

In the examination process, the first task to be performed is the selection of items to be included in the examination or to be considered for inclusion in the examination. Of course, this is a human function and cannot be accomplished, at least initially, by the computer. However, once the items are selected the teacher is ready to employ the computer in the examination process. The first task is the creation of exam item files. An exam item file created by TICAT can contain up to 128 true-false/multiple choice exam items. As a general rule, an exam item file is limited to a very narrow subject matter. The importance of this will be seen later.

The software associated with this function provides the user with a great deal of flexibility in the creation and editing of exam item files. In order to create or modify an exam item file the user logs on the system and requests and executes a library program named EGENER. The user is asked to name it and the computer then creates a computer resident file by that name. The user is then asked what task he/she wants to perform. The options are MAKE, LIST, COPY, EDIT or HALT.

The MAKE command is used to create new exam items for the file. Answering computer-generated prompts, the user supplies the text for the question, the correct answer and any textbook or other citation. In addition to these items the computer also stores data concerning the location of each item within the file and reserves space for storing information concerning item usage. A useful feature of this routine is that it keeps a running check on the amount of file space remaining and when more is needed it will exist from the routine and create additional space for the file. The user does not have to be concerned with the problem of enlarging

files. The reverse of that is that the routine keeps file size to the minimum thus avoiding tying up precious on-line storage space.

The LIST command provides the user with a listing of items from the exam file. The user has the option of listing all items, a range or single items. A listing provides a printed record of the exam items and is also useful in checking the accuracy of the items and for editing purposes.

The EDIT command enables the user to perform a variety of editing functions. It allows modification of the text of exam items in order to edit out typographical and other errors. Correct answers and reference citations can be changed. The editing features are designed to make it extremely easy for a teacher to update and edit exam files.

The COPY command allows the user to combine items from one or more TICAT created exam files creating a new exam file or adding to an old one. This is particularly useful in the situation where only a portion of the items in an exam file are applicable to the topic being tested. The teacher can select items from existing exam item files and create a new file which is tailored to the subject to be tested.

The HALT command is used to terminate the process of creating exam item files. It allows an orderly departure from the system. However, the author recognizes that users, especially non-computer types, have a way of exiting from a computer program in unorthodox ways; they walk away from the machine, just turn the machine off, or hit the "Break" key. While it is extremely difficult to anticipate all possibilities, the author has tried to assure that the exam item files will be left in usable condition regardless of how the user departs from the system. This is very important because otherwise the user will be dependent on computer center staff to try to salvage and repair "damaged" files.

Creation of an Examination

After the exam files have been developed, the teacher is ready to create an actual examination. This is done by requesting and executing the program EBUILD. EBUILD provides the user access to a set of programs designed to produce one of a variety of types of examinations and to establish the administrative files necessary to score examinations, keep records and produce reports once the examination has been given.

An examination is a set of items from one or more exam item files. When EBUILD is executed the user has the option of creating examinations using one of the following forms:

1. A set of examinations where each individual examination is a set of randomly generated items from each of the exam item files included in the examination. The user can specify the number of items to be selected from each of the files. The result is that each student will have a unique examination; no two will be alike.
2. A set of examinations where each individual examination is a set of randomly ordered items. In this case, all exams contain the same items but they are ordered differently.
3. A set of examinations where all individual examinations contain identical items and they are in the same order.

The teacher also has the choice of having the examination administered by the computer in an interactive mode or having the examination printed by the computer to be handed out and administered in a traditional fashion. When the interactive mode is specified the examination is administered by calling and executing the program EGIVER. The use of a CRT is particularly advantageous for this mode since no hard copy of the items will be produced. Once the teacher provides the computer with the necessary commands and code words the student takes the examination by responding to the computer generated questions. This mode is particularly useful for "individualized" and "self paced" instruction where students are not tested at the same time.

When the printed mode is selected the teacher specifies how many copies or versions of the examination are needed. The computer prints the desired number and assigns a code number to each version of the exam. The students record their answers on mark-sense data cards which can be read by a card reader interfaced with the computer.

Performance of Administrative tasks

The final set of programs associated with TICAT are designed to perform the administrative tasks of exam scoring, record keeping and report generation. These programs are accessed by calling and executing the program EADMIN. Using data either generated by the interactive administration of the examination or by reading in the answer cards, the user has the option of generating the following types of reports:

1. A Grade Report. This report lists a grade for each student and provides a profile of over-all class performance with the summary statistics of the mean, median, standard deviation, range and histogram.
2. An Individual Report for Each Student.

This report provides the teacher with a listing of the items that a given student has on his/her examination and the response given to each item. It also indicates the score that the student had for each section of the examination. This report is designed to be used by the teacher as a tool in counseling students about their specific problems with the subject matter. The teacher can request individual reports for all students or for individual students.

3. Exam Item File Report. This report provides the user with an over-all profile of the usage of a particular exam item file and student performance on items in the file. The report indicates the number of times that a given item has been used and the number of times that it has been answered correctly. It orders the items from those most frequently missed to those least frequently missed. Over-all summary measures for the file are provided. This report provides useful information for revising exam files and for indicating to teachers the type of information that students are not understanding.

Dynamic Nature of TICAT

It should be evident to the reader that the TICAT system was not designed for the teacher who wants to use the computer for a single examination or to use a set of exam items a single time. Rather, it was designed for the teacher who is involved in teaching the same subjects year after year and who uses similar tests each time. It is a dynamic system which allows for maximum revision of exam items and for a great deal of flexibility at examination time.

Security of the System

One of the important concerns that any teacher would have concerning the system is security. How certain can the teacher be that the exam items are secure against theft? This is indeed an important concern. The author has tried to provide maximum security. He believes that as much security exists with this method as with traditional methods of constructing and producing examinations.

First of all, all of the exam item files and the administrative files that are created for any given teacher are stored under his/her account number and are accessible only through that account, and with the Hewlett-Packard system this involves the use of a password. However, passwords and user numbers can be obtained by devious means from the computer center. With this in mind, the author relied on another form of security. At the time that an exam item file or an administrative file is created the user is asked to assign

a password or mask to that file. The mask can be a set of nonprinted characters. When the exam items, etc. are stored in the computer they are coded using the supplied mask. If a person attempted to list the contents of a given file without supplying the proper mask only unintelligible output would result. Not even computer center personnel would be able to unlock the code. Of course, as far as printed listings, etc. they would be subject to the same security problems as items produced by the traditional method.

Portability of TICAT

With regard to any software system, the question that is always asked is, How portable is the software? Can it be transported to other systems? Unfortunately, there is no such thing as a standard BASIC language. This being the case it is extremely difficult for any complex software system written in a particular version of BASIC to be readily moved from one computer installation to another unless the installations have computers that support the same version of the BASIC language. This is a most unfortunate situation.

TICAT is currently operational on a Hewlett-Packard 2000-ACCESS system and is written in the version of BASIC peculiar to that machine. Thus, the current version of TICAT is readily transportable to other H-P 2000-ACCESS systems. It is only a matter of placing the programs in the public library of the system.

For other systems, the solution is not as simple. TICAT makes use of several aspects of the language which are unique to H-P 2000-ACCESS BASIC. What this means is that for TICAT to be used by other systems substantial rewriting would have to be done. Interested persons could decide whether a revision would be possible and worthwhile or whether TICAT might just serve as a model for a new system.

CMI IN HAWAII
(A JOINT INTERNATIONAL EFFORT)

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Moanalua High School is currently implementing a CMI package which is the result of the combined talents and international efforts of its researchers consisting of two high school math teachers and a full-time systems developer from Japan. This paper describes the unique, exciting and profitable Japanese features that have been programmed into what would just have been another ordinary CMI package of which there are many in the U.S.A.

Computer Managed Instruction projects are plentiful throughout the country; several commercial firms have fully-developed CMI packages for sale, and many school districts have developed their own packages, usually through federal funding. A review of reports on available CMI programs clearly indicates that the successful ones are a result of teacher inservice education and teacher preparation and decision-making at the local level.

In CMI, the computer is used to help teachers by providing information on the progress on individual students and of the total class. The system can help the teacher to measure the effectiveness of his teaching, the progress of each student in his learning, and the necessary allocation of resources.

Before effective instruction takes place, the course must be defined in terms of the desired outcomes (the instructional objectives that the student is expected to meet). Given such a set of objectives instruments must be designed to determine how far each student is progressing toward meeting those objectives. The testing of each student with regard to these objectives must be an integral part of the instructional plan of the course; the results of each test must be used to provide individual and/or group remediation, as the results indicate. That is, tests should not be an end in themselves; they should contribute to the student's further learning.

Under normal classroom conditions, however, it is difficult for a teacher to find the time to fully analyze each test; just getting the test papers corrected, scored, and returned to the students within a short time is a demanding task. Teachers

are hard-pressed to find the time to do item analysis; much less to make individual prescriptions for each student to remedy those areas of weakness that become apparent in the taking of the test.

The computer then becomes a useful tool for the teacher. It can be designed to accomplish these tasks:

1. Correct each student's answer sheet.
2. Prepare reports for the student:
 - a. Student Performance List
 - b. Student Summary List

These reports for the student include:

- a. Test item number correlated with the number of the instructional objective being tested.
- b. Whether the instruction has already taken place on that objective
- c. Whether the student did the item correctly.
- d. Student score on that test form, and a cumulative listing of scores on all previous forms.
3. Prepare reports for the teacher:
 - a. Input Data List. (list of responses made by the student to each problem)
 - b. Correct Answer List.
 - c. S-P Score Table.
 - d. Objective and Item Analysis.
 - e. Cumulative Item Analysis.
 - f. Course Summary by Objectives.
 - g. Course Summary by Student.

The teacher has the freedom to determine the scope of each test. At Moanalua High School where this project is being piloted, the math department decided to capitalize on the "Comprehensive" part of the CAM, a CMI package developed at Stanford in 1967 and presently being used by the Sequoia Union School District in Redwood City, CA. CAM is the acronym for Comprehensive

Achievement Monitoring. Tests are always based on the total course. Students will then be attempting both problems on which instruction has already taken place, and problems not yet encountered but for that very fact may be challenging to the student. When a student responds to such challenge, he may accelerate his learning independently; or in class sessions, when a new topic is introduced, he may recognize the type of problem as one he had tried at some time on one of these comprehensive tests, called "monitors", and that recognition may "legitimize" the new topic and motivate him toward more careful concentration.

In February 1976, two teachers, Mrs. Barbara Kagan and Mrs. June Yamashita entered an agreement with the Japan-America Institute of Management Science (JAIMS), a Hawaii non-profit educational corporation, to perform a joint research on a Computer Managed Instruction project. JAIMS provided for this project a full-time educational systems developer, Mr. Masaru Takahashi from the Fujitsu Company in Tokyo, Japan. This project, hereinafter, called JAIMS-CAM is similar in many ways to the CAM package being used in Redwood City. JAIMS-CAM, however, does more than just "monitor" the progress of individual students and of the total class. Thanks to Mr. Takahashi, a number of interesting features have been included which are the result of current educational studies being done in Japan.

The most interesting and fascinating feature unique to JAIMS-CAM is the S-P Score Table (exhibit A). The S-P Score Table is a computer rearrangement of the rank of the students in a class (the vertical scaling) vs. the rearrangement of the test problems from easiest to most difficult (the horizontal scaling). The degree of difficulty of the problems is determined by the class' performance on the test. This is a multiple scaling procedure that was developed by Professor L. Guttman in Europe.

Two curves, the S-curve designated by the asterisks (*) and the P-curve designated by the dots (.) are then plotted on this S-P matrix. The (*) indicates the performance of each student and the (.) indicates the performance of the class on each problem. That is, the number of students who did correctly answer each problem.

The perfect (ideal) pattern for the ith student with a score of j correct answers, using such an S-P matrix will show 1's (indicating correct responses) to the left of the * and blanks or zeros (indicating wrong responses) to the right of the *. The * denotes the jth problem as ranked.

On the "EASY TEST" in fig. 1, ABLE's per-

formance is ideally patterned. Likewise, one finds that EDDIE's is also although at first glance, it doesn't appear to be so. Note that in EDDIE's case, he missed problem #1 (indicated by the blank to the left of the *) but did get problem #9 (indicated by the 1 to the right of the *). Both problems 1 and 9 are equally ranked. That is, 4 students each answered both problems correctly. This fact is reflected in EDDIE's warn which is identical to ABLE's 0.00. The warn will be discussed subsequently in this report.

NAME	CR	AVE	WARN	EV	PROBLEMS														
					2	4	7	8	10	12	3	6	1	9	11	5			
ABLE	12	100	0.00		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
BAKER	11	92	0.44		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CHAS	10	83	0.28		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EDDIE	9	75	0.00		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DAVE	9	75	0.27		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

correct ans score 5 5 5 5 5 5 4 4 4 4 4 3 2

DIFFERENCE = .10

----- S-curve
 P-curve
 "EASY TEST"
 fig. 1

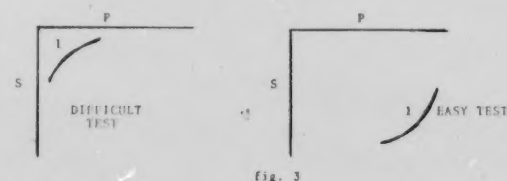
NAME	CR	AVE	WARN	EV	PROBLEMS														
					3	1	2	4	8	12	11	7	5	6	8	10			
FRAN	5	42	0.14		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
GEORGE	5	42	0.28		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HARRY	4	33	0.45		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IVAN	3	25	0.38		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
JACK	2	17	0.26		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

correct ans score 4 3 3 3 2 1 1 1 1 1 0 0 0

DIFFERENCE = .13

----- S-curve
 P-curve
 "HARD TEST"
 fig. 2

It is evident that the nature of the test (difficult or easy) as reflected by the class can be determined by inspecting this S-P curve. We will obtain the following basic shapes for each type as shown in fig. 3 below.



This S-P Score Table, prepared as indicated above, provides the setting for the calculation of two very interesting index variables.

1. The first is called the differential coefficient (DIFFERENCE). It represents the ratio of the area between the S-curve (*) and the P-curve (.) to the area of the whole S-P Score matrix.

As previously mentioned, the ideally

patterned S-curve and P-curve would find these two curves coinciding. Thus, the "ideal" difference would be zero (0), since the area between the two curves would be zero.

This means that each of the students is said to reflect the performance of the entire class. The i th student can get correctly those problems which many other students in the class can correctly answer.

2. The second index variable that can be determined is called the warning coefficient (warn). From statistics the covariance has been used to define this new variable called the warn, using the S-P Score matrix as a scatter diagram.

In statistics, when one attempts to discover the approximate relationship of two variables one usually begins by graphing the data as points in the x, y plane. Such a graph is called a scatter diagram.

In the S-P Score matrix, we have such a scatter diagram. Its variables are S (student performance score) and P (problem performance score) for the class being tested. The warn is defined mathematically as

$$\text{warn} = 1 - \frac{C_i}{C_{i(p)}} \quad (1)$$

where C_i is the covariance for the i th student;

and

$C_{i(p)}$ is the covariance of the ideal scatter pattern of the i th student.

The ideal or perfect pattern covariance is a determinable constant which is a function of the size of a class, the number of problems on a given test, and the mean performance of the class on each problem on the test.

If the value of C_i is large, then the performance of the i th student is said to reflect the performance of the entire class on the test. That is, the i th student can get the correct solutions for problems which many other students can correctly answer.

In the formula for the warn, $C_{i(p)}$ represents the covariance of the ideally patterned performance for the i th student with respect to his class. Theoretically speaking, he should have gotten correctly all problems to the left of the * and none to the right, since those problems to the right are more difficult.

As with the correlation coefficient, the ratio C_i to $C_{i(p)}$ ranges from -1

to +1. Hence, the warn (1) will yield a zero (0) if the pattern is ideal and the warn will range in value from 0 to 2. That is,

$$0 \leq \text{warn} \leq 2.$$

A large warn would be an indicator of abnormal patterns of scatter.

Remark. Our system is designed to print a single question mark (?) for EV when warn is greater than 0.50 and a double question mark (??) for EV when warn is 0.75 or larger.

The mathematical description of the warn and its derivation follows:

C_i is defined by the formula

$$C_i = \frac{\sum_{j=1}^n (y_{ij} - \frac{1}{n} y_{i.})(y_{.j} - \bar{y})}{n} \quad (2)$$

where (i) y_{ij} is the response of the i th student on the j th question. (The response is either 1 or 0.)

(ii) n is the total number of problems on the test.

(iii) $y_{i.}$ is the total number of correct responses for the i th student.

(iv) $y_{.j}$ is the total number of students who correctly answered the j th question.

(v) $\bar{y}$ is the average number of correct responses for each of the n problems on the test.

Multiplying out the parentheses in (2) and summing term by term will show that the numerator can be written as $\sum_{j=1}^n y_{ij} y_{.j} - \bar{y} y_{i.}$. Hence, we get

$$C_i = \frac{1}{n} \left(\sum_{j=1}^n y_{ij} y_{.j} - \bar{y} y_{i.} \right) \quad (3)$$

Since $\sum_{j=1}^n y_{ij}$ is the sum of all the responses (1, if correct and 0, if wrong) of the i th student on a test consisting of n questions, it is only necessary to sum up to the j th problem in the perfect (ideal) case. All subsequent problems, those to the right of the * would be 0's. That is to say, the i th student's total number of correct responses,

$$y_{i.} = \sum_{j=1}^{y_{i.}} y_{ij} \quad \text{or} \quad \sum_{j=1}^{y_{i.}} 1$$

since $y_{i.}$ (the student's score) would correspond to the j th problem as ranked.

Therefore,

$$C_{i(p)} = \frac{1}{n} \left(\sum_{j=1}^{y_{i.}} y_{.j} - \bar{y} y_{i.} \right) \quad (4)$$

The warn then becomes

$$\text{warn} = 1 - \frac{\frac{1}{n} \left(\sum_{j=1}^n y_{ij} y_{.j} - \bar{y} y_{i.} \right)}{\frac{1}{n} \left(\sum_{j=1}^{y_{i.}} y_{.j} - \bar{y} y_{i.} \right)} \quad (5)$$

$$= \frac{\sum_{j=1}^{y_{i.}} y_{.j} - \bar{y} y_{i.}}{\sum_{j=1}^{y_{i.}} y_{.j} - \bar{y} y_{i.}}$$

$$\begin{aligned}
&= \frac{\sum_{j=1}^n y_{.j} - \left(\sum_{j=1}^{y_{.j}} y_{1j} y_{.j} + \sum_{j=y_{.j}+1}^n y_{1j} y_{.j} \right)}{\sum_{j=1}^{y_{.j}} y_{.j} - B_{1j}} \\
&= \frac{\sum_{j=1}^{y_{.j}} (1 - y_{1j}) y_{.j} - \sum_{j=y_{.j}+1}^n y_{1j} y_{.j}}{\sum_{j=1}^n y_{.j} - B_{1j}}
\end{aligned}$$

Interpreting the warn in terms of the elements on the S-P matrix, we have the warn as the quotient of two differences. More specifically,

$$\text{warn}_1 = \frac{A_1 - A_2}{A_3 - A_4}$$

where

A_1 is the sum of the number of students who correctly answered those problems missed by the i th student to the left of the (*). (Indicated by 0's.)

A_2 is the sum of the number of students who correctly answered those problems that the i th student was able to answer to the right of the (*). (Indicated by the 1's.)

A_3 is the total number of students who correctly answered all problems to the right of the (*).

A_4 is the product of the score of the i th student and the mean (average number of correct responses for each of the n problems on the test).

The warning coefficient (warn) appears to be a very useful tool for helping the teacher to determine the validity of the scores obtained by any one individual student in a multiple-choice situation on which random guessing may occur, and therefore, the score may not truly reflect how much a student really knows.

In JAIMS-CAM a second warning coefficient (warn) has been programmed which appears for each of the test problems on the OBJECTIVE AND ITEM ANALYSIS report to the teacher. (See exhibit B.) It is also calculated from the S-P Score matrix and reflects the scattering patterns of the responses (correct or incorrect) made by the student on each problem. (The aforementioned warn (5) reflected the scattering patterns of the performance of each student.) This second warn, the warn of the j th problem is defined as

$$\text{warn}_j = \frac{B_1 - B_2}{B_3 - B_4}$$

where

B_1 is the sum of the scores of those students who missed the j th problem above the (.). (Indicated by 0's.)

B_2 is the sum of the scores of those students who correctly answered the j th problem below the (.). (Indicated by 1's.)

B_3 The sum of the scores of all students who correctly answered the j th problem above the (.).

B_4 The product of the total number of correct responses for the j th problem and the mean (class average).

A high warn here can indicate several things: (1) A difficult problem; (2) A "tricky" problem, one designed to entrap a student into making a particular response when another response is desired; and (3) A misconception and/or lack of mastery of a given skill or objective. As with the first warn, the system is programmed to print out a single (?) for EV if warn is less than .5 or is .5 when rounded up and a double (??) for EV if the warn is .5 or larger on the OBJECTIVE AND ITEM ANALYSIS report.

Finally, JAIMS-CAM contains an entropy which is found on the OBJECTIVE AND ITEM ANALYSIS report. It is another variable which can be useful to the teacher. The entropy measures the degree of scattering found in the responses made by the class on each problem. Its value is largest when the scattering of the responses is evenly spread over all the possible choices. On JAIMS-CAM as we have it designed, we have allowed for seven (7) possible responses; the five (5) that are indicated on the test, no response at all, and a choice other than 1 to 5. The latter was necessary because we have used in our initial development of this system a general purpose OMR card for answer sheet that has other possible markings.

The entropy is defined as

$$\text{entropy}_j = - \sum_{i=1}^7 P_i \log_2 P_i$$

where P_i is the fraction of the class that made the i th response as its choice on the j th question.

(Note: Entropy ranges from 0.0 to 2.5.)

In conclusion, we believe that JAIMS-CAM system is superior to any other computer managed instruction system that we have investigated, in the U.S. or elsewhere. The features incorporated within JAIMS-CAM provides the classroom teacher with a more comprehensive analysis of both

gies and course organization can eventually result.

Reference: Sato, Takahiro, S-P NO SAKUSEI TO
KAISHAKU, Meiji Tosho Shuppan, Tokyo, Japan
1975.

EXHIBIT A

S-P SCORE TABLE (o --- P CURVE, • --- S CURVE)

-----TEST ADMINISTRATION TIME 3 (DATE 1215)-----

```

PROBLEM NUMBER 32 26 39 23 27 18 36 43 13 34 23 17 35 29 40 43 22 31 19 21
PRE-POST-RETN 15 50 37 16 41 24 42 14 47 38 49 28 20 12 30 48 46 33 11 44

```

218 MCANALUA
318 PRE-ALGEBRA
323 ITO L

[illegible]

790014	10	LAMBERT RA	28	70	0.47	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
80013	T	MASEGAWA T	26	65	0.16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
800147	9	KIKUCHI G	26	65	0.24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
277181	9	MARKS STAN	26	65	0.33	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
963615	9	SUJ SUSAN	26	65	0.42	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
921277	10	CAMELLO L	25	62	0.65 ?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
963852	9	WATTENBARG	24	60	0.36	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
869446	9	RAWLINS MA	23	57	0.28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
766362	9	YAHAGUCHI	23	57	0.33	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
790098	10	POAGE SHER	23	57	0.33	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
868108	9	PATFETTE T	22	55	0.35	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
864388	9	BLANCHARD	22	55	0.36	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
867884	10	OKOUCHI T	21	52	0.25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
800079	9	WATANABE M	21	52	0.32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
864146	9	NAKANO BRI	20	50	0.21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
966094	10	SIMCOX TIM	20	50	0.34	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
800120	9	DUCLAYAN D	20	50	0.34	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
863856	12	SANTOS TH	18	45	0.32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
800207	9	PATTERSON	18	45	0.34	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
764057	9	TOGIKAWA E	18	45	0.50 ?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
764109	9	DITTO BENE	18	45	0.60 ?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
865890	10	MOSELEY JE	16	40	0.19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
790013	10	KUDOTAMA B	14	35	0.67 ?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CORRECT ANS SCORE						22	21	20	20	18	14	17	15	14	13	12	11	11	9	7	7	7	7	6	3	1		
							21	20	20	18	18	16	14	14	13	12	11	11	8	7	7	7	7	5	3	0		

DIFFERENCE = 0.20

EXHIBIT B

OBJECTIVE AND ITEM ANALYSIS

-----TEST ADMINISTRATION TIME 3 (DATE 1219)-----

TOTAL STUDENT NUMBER WHO RECEIVE TEST = 23
ABSENT STUDENT NUMBER = 1

218 MOANAUA
318 PRE-ALGERIA
313 ITO L

PROBLEM	OBJECTIVE	INS	ANS	SCORE	PER %	R	E	S	P	O	N	S	E (%)	ENTROPY	WARN	EVA
						NO	1	2	3	4	5	OTHER				
32	11065	3	5	22	95.7	0.0	4.3	0.0	0.0	0.0	95.7	0.0	0.3	0.0		
15	1111	3	3	21	91.3	0.0	0.0	0.0	91.3	0.0	8.7	0.0	0.4	0.6	?	
26	1133	3	3	21	91.3	0.0	8.7	0.0	91.3	0.0	0.0	0.0	0.4	1.3	??	
50	4040	2	3	20	87.0	4.3	4.3	0.0	87.0	0.0	4.3	0.0	0.6	0.1	?	
39	2145	3	4	20	87.0	4.3	4.3	0.0	0.0	4.3	87.0	0.0	0.8	0.5	?	
37	2070	3	4	20	87.0	0.0	4.3	0.0	4.3	87.0	0.3	0.0	0.3	0.6	?	
25	11113	3	4	20	87.0	0.0	4.3	0.0	0.0	0.0	13.0	0.0	0.6	0.8	??	
16	3011	3	2	20	87.0	0.0	0.0	87.0	0.0	0.0	0.0	13.0	0.0	0.6	0.8	??
27	2045	3	1	18	78.3	0.0	78.3	0.0	0.0	0.0	21.7	0.0	0.8	1.2	?	
41	2115	3	4	18	78.3	0.0	4.3	4.3	4.3	78.3	8.7	0.0	1.2	0.6	?	
74	4024	1	3	18	78.3	0.0	0.0	4.3	78.3	8.7	8.7	0.0	1.1	0.7	?	
~	11011	3	2	18	78.3	4.3	0.0	78.3	0.0	4.3	13.0	0.0	1.1	1.0	??	
36	5013	2	7	17	73.9	0.0	8.7	8.7	0.0	73.9	8.7	0.0	1.2	0.5	?	
42	3062	3	3	16	69.6	0.0	0.0	13.0	69.6	13.0	0.3	0.0	1.3	0.7	?	
45	10053	3	2	15	65.2	0.0	21.7	65.2	0.0	8.7	4.3	0.0	1.4	0.7	?	
14	13019	1	2	14	60.9	0.0	8.7	60.9	8.7	8.7	13.0	0.0	1.7	0.6	?	
13	12014	3	4	14	60.9	4.3	4.3	13.0	0.0	60.9	17.4	0.0	1.7	0.6	?	
47	10121	1	4	14	60.9	4.3	0.0	8.7	17.4	60.9	8.7	0.0	1.7	0.8	??	
34	7053	1	1	14	60.9	0.0	60.9	0.0	26.1	13.0	0.0	0.0	1.3	0.9	??	
30	5101	1	4	13	56.5	0.0	0.0	30.4	8.7	56.5	4.3	0.0	1.5	0.6	?	
23	4061	2	2	12	52.2	0.0	8.7	52.2	13.0	0.0	21.7	0.0	1.2	0.9	??	
49	12033	3	2	12	52.2	0.0	17.4	52.2	4.3	4.3	21.7	0.0	1.8	1.1	??	
17	4015	1	2	11	47.8	0.0	21.7	47.8	4.3	13.0	13.0	0.0	2.0	0.3	?	
28	5142	3	4	11	47.8	0.0	30.4	0.0	8.7	47.8	13.0	0.0	1.7	0.8	??	
35	11132	1	4	11	47.8	4.3	0.0	26.1	8.7	47.8	13.0	0.0	1.9	1.0	??	
20	6105	3	4	11	47.8	0.0	17.4	0.0	0.0	47.8	34.8	0.0	1.5	1.0	??	
29	9022	1	1	9	39.1	0.0	59.1	21.7	4.3	13.0	21.7	0.0	2.1	0.9	??	
12	4042	1	4	8	34.8	0.0	0.0	26.1	17.4	34.8	17.4	0.0	1.9	0.2	?	
40	5061	1	2	7	30.4	0.0	30.4	0.0	17.4	17.4	30.4	0.0	2.1	0.5	?	
30	8031	1	2	7	30.4	0.0	8.7	30.4	8.7	17.4	34.8	0.0	2.1	0.9	??	
43	7043	3	3	7	30.4	0.0	13.0	17.4	30.4	21.7	17.4	0.0	2.3	0.9	??	
48	13062	1	4	7	30.4	4.3	26.1	17.4	4.3	30.4	17.4	0.0	2.3	1.0	??	
27	5093	2	5	7	30.4	0.0	0.0	0.0	4.3	56.5	8.7	30.4	1.5	1.0	??	
46	3141	1	4	7	30.4	0.0	59.1	21.7	0.0	30.4	8.7	0.0	1.8	1.0	??	
31	8091	5	3	6	26.1	0.0	13.0	34.8	26.1	0.0	26.1	0.0	1.9	0.4	?	
33	13084	2	3	5	21.7	4.3	8.7	21.7	26.1	13.0	26.1	0.0	2.4	0.4	?	
19	10061	1	3	5	13.0	8.7	26.1	13.0	4.3	30.4	3.6	0.0	2.1	0.6	?	
11	6053	1	3	3	13.0	8.7	0.0	21.7	13.0	0.0	47.8	0.0	2.0	0.8	??	
21	1022	3	2	1	4.3	0.0	91.3	4.3	0.0	0.0	4.3	0.0	0.5	0.0		
44	9054	3	4	0	0.0	0.0	4.3	8.7	4.3	0.0	82.6	0.0	0.9	0.0		

COMPUTER BASED EDUCATION: HOW COST EFFECTIVE
IS IT FOR SECONDARY AND POST-SECONDARY EDUCATION?

Dr. Eugene G. Kerr
Control Data Computer Based Education Company

Various Computer Based Education Systems available in the commercial market place are presented. Each of these are reviewed as to their costs. Several examples are presented that point out the cost effectiveness of Computer Based Education for Secondary and Post Secondary Education. Costs are examined both from a curriculum development view as well as a daily operations view. Recommended steps are presented for Educators currently investigating Computer Based Education or planning to in the near future.

During the sixties and early seventies, Computer Based Education (CBE) has continued to be highly touted as a solution to educational problems. CBE is defined as being any teaching or learning activity that makes use of a computer. The computer can be used to provide Computer Assisted Instruction (CAI) and Computer Managed Instruction (CMI), individually, together, or in combination with multimedia learning activities, conventional class room activities and individualized courses. Proponents of CBE claimed that it would free teachers from routine and often dull Drill and Practice, and free them for more creative work and personal attention to the needs of individual students. Students would be able to work at their own pace, with concentration on their areas of weakness. Slower students would be freed from the embarrassment of having to struggle for correct answers in front of their waiting classmates, and faster students would not have to wait on the slower members of the class.

All the advantages mentioned above were and still are laudable, but even though many CBE systems were demonstrated to be educationally sound and educationally practical there still has been no rush to make use of them in secondary and post-secondary education. The primary reasons for this appear to be economical rather than educational. A common statement heard while discussing CBE with educators is: "Well maybe in 5 - 10 years when the costs are considerably less". Kerr and Bright (1974) found that:

"Educators began to regard CAI as an elegant but an impractical idea. Computers were increasingly restricted to scheduling duties and other administrative tasks. A new field of appli-

cation, CMI, or Computer Managed Instruction developed in the meantime. Tests and Instructional materials were assigned to individual students based on an initial assessment of their abilities and achievements, and the computer printed out the next best step for that student to take. But as far as being used directly as an Instructional Device, Computers in Education were rapidly becoming a dead issue."

An interesting and provocative event has taken place in the last five years that this author believes calls for the re-examination of CBE by secondary and post-secondary schools. Business and industry and the military have found CBE to be a practical and cost effective answer to many of their training problems (Kerr, 1974). Based on this interest and potential, more and more vendors of CBE products (Hardware, Software, Courseware, and Consulting) are turning to business and the military to enlarge the use of their CBE products (Hickey, 1976). This means that an increased amount of CBE products are becoming available much of it being produced by large vendors with the result of having definite and stable prices.

The major purpose of this paper is to review several of the currently available commercial CBE systems and to examine their cost effectiveness in relation to secondary and post-secondary education. Though there are many technical advances in the offing (Micro-computers, video-disc, cheaper data communications, computerized course development), this paper will only deal with current commercial offerings and how they might be cost effectively applied to secondary and post-secondary education.

The CBE systems that will be referred to are:

- . Control Data Corporation
PLATO System... (A Hardware/Software System)
- . Hewlett Packard
(HP 2000, 3000 Systems)
- . Digital Equipment Company
(Classic)
- . Mitre Corporation
(TICCIT System)
- . GETSS
(CAISYS)
- . Univac
(ASEI)
- . McDonnell Douglas
(Time System)
- . IBM
(ITS and Coursewriter III)
- . Boeing Co.
(Scholar/Teach)
- . Westinghouse Learning
(PLAN)
- . System Development Corp.
(PLANT)

Control Data Corporation: CDC has just set up a separate company Control Data Education Company to market various CBE products. Their services include:

Learning Centers: Training in CBE (\$3000) PLATO terminal time (\$12.70 per hour) and various courses (Many former University of Illinois courses are available along with new ones being developed specifically for the secondary and post-secondary market.) CDC has over 25 centers currently installed and are expanding to cover the 30 major cities by the end of '77.

PLATO Courses: A course ware company is developing a wide range of courses many of which have applicability to education.

Consulting: Instructional Design, Programming, and Implementation available at rates from \$30 to \$60 per hour.

CMU: Available at Learning Centers (\$12.70 per hr.) or over leased services (\$1000 per month per terminal).

Hewlett Packard: HP has for a number of years provided CAI as a part of their HP 2000 and 3000 series Hardware. They have developed a CAI language that makes it

easier to develop Learning Sequences. Normally a user is required to purchase or lease a system (\$75,000 - \$200,000) for \$1500/mo to \$4000/mo) in order to use this system; though in some cases time is available from other users or small service bureaus at \$3 - \$4 per hour.

Digital Equipment Corporation: DEC has similar systems to HP that can and do provide CAI for many users. This is usually on their PDP 8 or PDP 11 Hardware and most often uses BASIC. In addition to this, DEC has produced a terminal oriented mini-computer for teaching called the Classic. It leases for \$300 - \$500 per month and supports a small number of display terminals.

Mitre Corporation: MITRE's TICCIT System along with The University of Illinois PLATO has been highly publicized. TICCIT was originally designed to deliver instruction to the two year college. TICCIT is not a truly commercial product as yet, but has been demonstrated so often that it has been included here. The cost has been estimated at between \$1 and \$3 per contract hour.

GETSS: The General Electric Time Share Service is similar to other TSS (Tymshare, Call 360, and many regional companies). They offer BASIC as well as a CAI Language CAISYS (Developed by Toronto Dominion Bank) for about \$8 - \$15 per hour depending on the services used.

UNIVAC: UNIVAC has successfully been offering CAI on their medium scale and larger systems. They use a CAI language called ASEI. These systems lease for \$5000 and up per month. Their most advertised project has been in Chicago which supported Drill and Practice in reading, language, and math.

McDonnell Douglas: McAUTO has mainly provided CAI/CMU Software (TIME System) to run on medium to large scale IBM system. Their major thrust has been in industry with some forays into education. The software sells for \$25,000 to \$50,000 installed on your system. Their most successful education activity has been for the State Board of Education in Utah where it was used in implementing the USAIL project. (Utah System for Automated Individualized Learning). Using the TIME System allowed daily assignments and record keeping on students. The pilot of 100 students averaged \$18 per student per year and dropped to below \$10 when the number exceeded 600.

IBM: IBM has long been involved in CAI starting in the early sixties with Coursewriter I. Coursewriter III is now available on their medium to large systems. In addition, the Interactive Training System (ITS) designed mainly for industry is

available on larger systems using IMS, CICS, and TSO. Because of their longevity in the business, there is more courseware written in Coursewriter III for education than in any other CAI Language Systems using Coursewriter lease from about \$7000 per month.

Boeing Co.: BCS has worked for several years with a CAI language called Scholar/Teach. This language has been enhanced and is now being offered in a version for IBM medium to large scale computers. BCS's major emphasis is still industry. There are plans to offer Scholar/Teach as both a software package and as a net work service (\$10 - \$15 per hour). Courseware consulting is also available at standard rates from \$30 - \$60 per hour.

Westinghouse Learning Corporation: Westinghouse has been involved mainly with CMI with their PLAN system which has been widely tested. This is an individualized program that uses CMI to keep the records and monitor the progress of students. The current cost is in the \$50 - \$90 per student per year range depending on how the system is implemented by a school district. It is primarily aimed at the upper elementary and junior high levels.

System Development Corporation: SDC's PLANIT system for CAI has been around for a number of years. It is a software package that will run on medium to large scale IBM equipment. It has in the past been available as a Time Share service from SDC.

This paper does not make any attempt to judge the various commercial versions of CBE systems. Each one has its strong points and weak points along with many and often vociferous adherents. The fact that each one has retained a presence in the commercial market place indicates its usefulness. Rather this paper will examine if it is possible to implement CBE systems in secondary and post-secondary environments from a cost effectiveness point of view. A quote from Kerr and Bright (1974) is appropriate to this point.

"When new capabilities, new personnel, new tools and new technologies are introduced into the situation, the immediate impulse is to apply these new resources to the old procedures, in hopes of making them less costly and more effective. But new tools offer new possibilities. Unfortunately, educators often do not realize that new tools might make old compromises unnecessary."

Thus a fresh look at how CBE can be applied is often required if it is going to be cost effective. In addition, in order to locate the areas where CBE might be effectively applied, school people are going to need a firm hand on the costs of the various activities within the education process.

Finally, CBE must not be looked on as an experimental add-on. If it cannot be justified in a normal production fashion in the regular educational setting then it should not be considered. The following examples illustrate these points.

Example 1. Development and Testing of Individualized Curriculum.

This example takes its lead from industrial applications of CBE. The major reason that business and industry have been successful in making cost effective use of CBE is that they are paying salaries to the people that they are training. Educators have argued that this is not true in education. They only have from \$1.00 - \$3.00 per student contact hour to work with and in most cases all of these amounts are not cost replaceable. Very often this is true, but what about those areas of endeavor where staff is used for other activities. An immediately apparent one is where staff time is being released or hired separately to design, develop, test, and implement Individualized Learning Systems. This is being done in many community colleges as well as secondary schools. Both the training of staff in appropriate skills and the support of them in the process are highly applicable areas for CBE and could be adequately supported by several of the CBE systems listed above.

Since budgets are limited and often this money has to be extracted from other on going activities any cost savings should be welcomed. Experience in industry has shown that the cost of developing individualized materials using CBE is often from 30% - 50% less than the cost on a purely manual basis. (Goddard, 1974.) In addition, the learning materials are more thoroughly tested. The CBE systems with strong CMI components are especially designed for this type of application.

Example 2: High Cost Areas

Though the average cost for a community college might be \$1.50 per student contact hour, there are many programs that cost \$4, \$5 or even \$15 - \$20 per contact hour. If the educational institution has a firm knowledge of each of its program costs, then these high cost programs are ideal places to examine for the implementation of CBE. Let's use as an example a community college program for Nuclear Technicians. The average contact hour cost for this program is \$7 - \$10 per hour. This cost is due both to the high cost of equipment for the program and to the low pupil to teacher ratio required by the content approach. An additional problem in this particular area that makes CBE even more practical is the difficulty of obtaining qualified instructors. By converting those aspects of the learning

materials adaptable to CBE, it would be possible for an instructor to handle almost twice as many students. Since the cost of applicable CBE systems is in the \$3 per contact hour range, it would be possible to reduce the per hour cost average from \$7 - \$10 per hour down to a figure of \$5 - \$7 per contact hour. This would reduce the overall cost of that program and make those funds available to other programs.

Example 3: Let's Make It Production

Though it is true that for day to day operations the cost of CBE for certain high cost programs is justifiable, there are still problems to consider in the cost of course development. Unlike business, educational institutions are not set up to capitalize course development. If the average time to design, develop, test, and implement CBE learning materials is 100 - 200 manhours per hour of student contact, then where is the money for this cost going to come from? As is apparent, curriculum development is going on every day in every educational setting (Instructors are suppose to be preparing for their classes, special planning periods are set aside, curriculum committees meet regularly).

Again industry has developed techniques that apply to the above. Though industry does have capabilities to capitalize much easier than public education, early users of CBE often had to evolve into the use of CBE to reduce costs. The following is an example of a course "Data Processing for Managers" developed by a financial organization:

Phase I	20%	CMI
	5%	CAI
	5%	Media
	70%	Discussion Groups
Phase II	20%	CMI
	20%	CAI
	20%	Media
	40%	Discussion
Phase III	20%	CMI
	40%	CAI
	30%	Media
	10%	Discussion

This allowed the instructor to move the course from mostly instructional centered to mostly individualized. The CMI capability was critical to this evolutionary process.

This process appears to be applicable in education - especially in those areas that are already scheduled for individualization and have a daily operating cost high enough to make CBE feasible. CBE does not need to be something experimental and tacked on top of current budgets. The

above technique allows CBE to gradually evolve into use without increasing the cost over current operations.

Summary and Recommendations: The commercial availability of a wide variety of CBE capability allows secondary and post-secondary education to examine its use in a production way. Costs are stable and features are well defined. System support is available and competent. Educators and administrators have every reason to re-examine CBE and consider it for use in their institution. The following steps are recommended:

1. Look at fresh new areas. Review those areas where additional funding is required such as in-service training, curriculum development, testing, counseling or any area where the tasks currently being performed by staff could be reduced or eliminated by the use of CBE capabilities. You may never use CBE to instruct students, but may greatly reduce costs of preparing instructional systems for student use.
2. If not available, determine the actual costs of all operating programs. Review all the high cost programs for the applicability of CBE. Particularly look for those programs where expansion is stymied by lack of trained instructors or where interest in teaching the course is low.
3. Think of CBE as an available production tool not as an experimental add-on. Review closely the idea of evolving from instructor intensive to media and technology intensive in those courses where this approach makes sense. This will result in reduced operating costs for those courses.

Goddard, Bernard H., "The Use of Computer Assisted Instruction at McDonnell Douglas Corporation". AFIPS Conference Proceedings, AFIPS Press, Montvale, New Jersey, 1974, 953-955.

Hickey, Albert E., "Computer-Assisted and Computer Managed Instruction". Training and Development Handbook, McGraw Hill, New York, 1976, Section 40.

Kerr, E.G., "Business and Industry in the 70's Find Computer-Aided Instruction A Practical Answer to Training Problems". AFIPS Conference Proceedings, AFIPS Press, Montvale, New Jersey, 1974, 929-932.

Kerr, E.G. and Bright, R.L., "Computer-Aided Instruction is Feasible Now". Technical Education Reporter, Vol. 1, No. 2 July - August 1974, 60-67.

COMPUTER DATA PROCESSING
COMPETENCIES NEEDED BY PERSONNEL
IN SELECTED DISTRIBUTIVE
OCCUPATIONAL CATEGORIES

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The analysis of a study of data processing competencies by distributive workers is described. The purpose of the study, method, summary and recommendations is presented in abstract form.

STATEMENT OF PURPOSES:

The intent of this study was to investigate the various computer skills and knowledges that people in distributive occupations should possess, and at what level of proficiency they should possess them. The specific purposes of this study were:

1. To compile a summary of the types of firms and the types of people completing the questionnaire.
2. To develop a knowledge of what computer equipment is used in distributive occupations.
3. To develop a knowledge of what the job classifications are of those distributive occupations people who communicate with the computer.
4. To determine if the people who communicate with the computer have been trained in computers other than actual machine operations.
5. To determine what the various frustrations are of the people who communicate with the computer.
6. To gather the opinions from sellers of computer equipment to distributive occupations personnel, and the opinions from users of computer equipment who are engaged in distributive occupations, as to what the computer skills and knowledges of people employed in distributive occupations should be.
7. To determine the importance of the various computer skills and knowledges from two groups of people: (1) the workers themselves, and (2) the supervisors of these workers.
8. To provide teacher-coordinators and teacher-educators with a summarization of computer data processing concepts that should be considered for inclusion in a course of study for distributive education courses.

METHOD AND SOURCES:

A questionnaire was developed by the writer with the help of an advisory committee. It was decided to go directly to those people employed in a distributive occupation who currently were using computer data processing in performing their jobs. It was also decided that the respondents would be of two groups: (1) the workers themselves, and (2) the supervisors of the workers. The population included 118 Minneapolis/St. Paul, Minnesota area firms.

The follow-up procedure to respondents who did not return questionnaire consisted of telephone calls and letters encouraging them to complete and return the questionnaire. The return rate was 73 percent of the supervisors and 43 percent of the workers themselves.

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS:

Findings: Findings included background information providing data about the respondents, the participating firms, the brands of equipment being used, the peripheral equipment being used, the job classifications of those people communicating with the computer, the training of the users, the expressed frustrations of the users, and finally the aggregate analysis of businesses on 91 job duties and knowledges related to the computer. Conclusions: The following conclusions can be drawn as a result of the study:

1. Seventy-three percent of the respondents were in a distributive occupation. The respondents not in a distributive occupation indicated they had received the questionnaire to answer because the original receiver felt unqualified to answer the questionnaire.

2. A wide variation of computer equipment confronts the business world today. The findings of this study showed that while the business firms surveyed used varied brands of computers, one particular brand does stand out and that is IBM. The types of peripheral equipment used are also varied and numerous.
3. The respondents were asked to indicate the job classifications of those people communicating with the computer. While there were some common job titles, those of salesperson and sales manager seemed to be fairly common to all program areas. However, the titles varied a great deal across the instructional program categories.
4. The lack of training of computer users in computer concepts resulted in a variety of stated job frustrations. This was evident from the number and kind of frustrations listed by the respondents, and they also indicated that there had been a lack of training in computer concepts. It would appear that a lack of training leads to some frustration on the job. However, the frequency and degree of frustration were not determined in this study.
5. The questionnaire included 91 computer skills and knowledges that were gathered with the help of an advisory committee which consisted of two vendors, one user, and one vendor/user. While the opinions of the supervisors did vary slightly from the opinions of the users, no significant conclusion can be drawn from the difference. Therefore, a composite proficiency rating was presented showing the most important skills and knowledges down to the least important skills and knowledges.
6. The most highly rated job skills and knowledges were in the areas of accuracy, communication, self-importance, changes within a firm, overall business organization, the importance of the role of the computer in the firm, and interpretation of computer reports.

Recommendations: The following recommendations pertaining to Minnesota are made in view of the investigator's experience during this study. Based on the data gathered, it is anticipated that the computer will be used more extensively by distribution-oriented business firms.

1. Therefore, curriculum should be developed for distributive education students in basic computer concepts, especially for those occupational categories which draw heavily on these skills (e.g., advertising, apparel and accessories, finance, general merchandise and insurance).

2. Distributive education students, particularly those who have career goals in those occupations which seem to require greater computer knowledge and skill, should be taught basic computer concepts in both high schools and post-secondary schools.
3. The Distributive Education Unit Staff, Vocational-Technical Division, of the Minnesota State Department of Education, should encourage teacher-coordinators to take a computer data processing general concepts course as part of their college training, or for updating their credentials.
4. Teacher-coordinators, on their own, should seek training in basic computer concepts.
5. A textbook and study guide should be written for distributive education students incorporating those job skills and knowledges resulting from this study.
6. Schools should investigate the possibility of running some adult classes in basic computer concepts for distributive workers.
7. Teacher-coordinators should explore the possibility of placing students in jobs as part of their cooperative experience which involve computer skills.

The experience gained in this study suggests a number of other studies that would produce information of value to distributive education. These suggested studies are as follows:

1. A separate study should be conducted to determine what computer data processing training distributive education teacher-coordinators should possess in order to train their students.
2. This type of study should be conducted every 3-5 years in order to keep abreast with the rapid changes in the computer and business world.
3. The study should be conducted nationally and a comparison made to see if what is true locally in the Minneapolis/St. Paul, Minnesota Area would also be true nationally. Perhaps it would be more appropriate as a doctoral study.
4. This study could be conducted again in the Minneapolis/St. Paul, Minnesota Area for a validity check.
5. A similar study could be conducted with two groups; one that had previously been trained in basic computer concepts and one that had no training in that area, and make a comparison between the two groups.

COMPUTER MANAGED INSTRUCTION: EVALUATION OF A TWO-YEAR PILOT TEST

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Systems of computer managed instruction have been developed to assist teachers and other educational decision makers with the record keeping and management problems associated with programs of individualized education. The Wisconsin System for Instructional Management (WIS-SIM) has been developed to address specifically the management needs of programs of Individually Guided Education. WIS-SIM has been pilot tested in 16 schools in Wisconsin and Minnesota from 1974-1977. Evaluation of the pilot test has considered school, perceptual and attitudinal data concerned with system functioning, utilization and effects. Results indicate positive attitudes, reduction in teacher time spent in clerical activities and increased pupil progress.

Recent innovations in the structural organization of elementary schools and individualized instructional programming have greatly increased the complexity of instructional record keeping and decision making. Individually Guided Education is one such innovation and is comprised, in part, of a multi-unit school organization and an instructional programming model (Klausmeier, 1974). The multi-unit school organization places between 100 and 150 students together with 4 to 6 teachers and perhaps a student teacher and a teacher-aide to form an instructional unit. Each school contains several such units; the actual number of units depending upon the size of the school. The instructional programming model requires teachers to formulate general goals for their unit and to develop specific individual goals for each student. The goals specified for each student are operationalized in terms of a set of measurable objectives, which are the focus of the student's work over the next several weeks. Students are pretested on one or more of the objectives. If the student attains the performance criteria on the pretest, then the student would proceed to another objective. Students not attaining the performance criteria and having satisfied all prerequisite objectives, are ready for instruction on the objective. The instructional programming model emphasizes the use of small and medium sized groups for instruction, although individual work and large groups are also utilized. These groups are formed on the basis of common instruc-

tional need as well as other factors which are important in the teaching/learning process, e.g., motivation, interests and learning styles.

What does such a program of individualized education mean for teachers? Presumably it means that the teachers are better able to meet the individual needs of students, but it also means that teachers are faced with record keeping problems and requirements for information about student instructional needs and characteristics not apparent before, this information being utilized in making decisions about instructional programming for the individual student.

The Wisconsin System for Instructional Management (WIS-SIM) is a computer-based instructional management information system developed specifically to provide teachers and other educational decision makers with the information they need to implement programs of Individually Guided Education (Spuck, 1977). This system of computer managed instruction has been in development since 1971 and has been pilot tested in three curricular areas and in seven elementary schools located in four Wisconsin school districts, supporting a total of approximately 2,500 students. Additional pilot test efforts have been conducted in several additional schools in a Minnesota school district. This report presents some preliminary results of the pilot test of this system.

The main function of the Wisconsin System of Instructional Management (WIS-SIM) is to improve instructional decision making

in order to maximize educational progress for each child while making efficient use of the available human, material, and financial resources (Spuck, 1977). Unit teachers are key instructional decision makers. They have frequent need for information, because they have the responsibility for planning and implementing an instructional program suitable for each student. Children also may be significant decision makers because they may be involved with their teachers in establishing specific instructional objectives. Parents play a key role in influencing student motivation and learning and often are involved in establishing instructional objectives and monitoring their attainment. In order to establish optimum learning environments and make efficient use of school resources, it is necessary to make appropriate and timely information available to these various decision makers.

An examination of the basic structure of programs of individualized education led to the following assumptions which are the basis for the design of WIS-SIM:

1. The program is defined in terms of sets of instructional objectives.
2. Testing instruments and/or procedures which may be used to assess mastery of the instructional objectives are available.
3. Level(s) of achievement or performance standards are specified for each child and for each instructional objective (full mastery-variable attainment).
4. Objectives which are to form a part of each student's instructional program are delineated (common objectives-variable objectives).
5. Dependencies or prerequisites existing between objectives are specified (sequenced objectives - nonsequenced objectives).
6. Normative information exists, as required, upon which to base reasonable long-range performance expectations.
7. Educational activities and materials exist and will be utilized to provide individualized instructional experiences leading to the accomplishment of the specified instructional objectives.
8. It is possible to assess quantitatively and/or qualitatively the individual characteristics of students that must be considered in planning individualized instructional activities.
9. It is possible to assess quantitatively and/or qualitatively the resources required for the various alternative educational experiences (Spuck, Hunter, Owen, & Belt, 1975).

Three instructional decision areas which may be derived from the instructional

programming model are central in the design of the WIS-SIM: specifying performance expectations, identifying instructional need, and selecting appropriate instructional experiences and settings. Each of six major processes of testing, test scoring, achievement profiling, diagnosing, guiding the instructional program and instructing provide information to the data bases or result in reports which are used by teachers in making one of the three decisions included in the model.

Six design goals were used as guides in the development of WIS-SIM:

1. To facilitate the learning environment for each child in terms of the instructional and organizational requirements of Individually Guided Education;
2. To provide information which is useful to educational decision makers at the unit, school, and district levels;
3. To improve communications with parents and upgrade the quality of reporting to them concerning student achievement;
4. To make minimal of demands on teachers to "learn" the system;
5. To make minimal demands on teachers to perform tasks which are different from normal classroom activities and, where possible, to reduce the paper work and clerical requirements of school personnel;
6. To make computer management of instruction available to a large number of IGE schools (Belt and Spuck, 1974).

The evaluation is considered primarily formative, because WIS-SIM is still under development. As the need for changes was demonstrated, then these changes were incorporated into the system as soon as possible, rather than waiting for the pilot test to be completed. While such a strategy confounds the effects of the system during the pilot test, in that the features and capabilities of the system are changing, it does provide an incrementally improved system. It is anticipated that an evaluation of a more summative nature will be conducted during later field tests.

The evaluation design consists of four major parts, as outlined in Table I. These parts consist of evaluation of the in-service program, system functioning, system utilization and system effects. System functioning and system utilization are considered as implementation evaluation and system effects are considered progress evaluation (Spuck, 1976). Three types of data were considered, as indicated in the table, that is, actual, perceptual and attitudinal. Actual data consisted of "hard" data on system operations, observations, and student test

TABLE 1: WIS-SIM FORMATIVE EVALUATION PLAN

	Implementation Evaluation		Progress Evaluation
ACTUAL	In-service Evaluation	System Functioning	Utilization of System
	Pre-test Post-test	Try-out	Number of System Accesses
	Knowledge and Understanding	Turn-around Time	Usage of Reports Costs - Total - Per Student - Per Report
PERCEPTUAL	Perceptions of Utility of Inservice	Suggestions for System Revision	Perceptions of Report - Usefulness - Appropriateness
			Role Changes for Staff Changes in School Operations Quality of Decision-Making Quality of Information for Parents
ATTITUDINAL	Attitude Toward Inservice	Attitudes Toward System Reliability and Convenience	Attitudes Toward System Utility and Efficiency Attitudes Toward System Effects

results. Perceptual data were typically derived from descriptions of the system and its effects by school staff members. Attitudinal data included school staff descriptions of their feelings about system operations and effects. Noted in the body of the table are specific data collected during the pilot test. The data listed are not totally comprehensive, but are believed important to the assessment of the goals of the system. The quality of information would generally be improved if perceptual data could be collected as actual data. However, many times it was not possible to obtain actual data, and perceptual data was substituted. These data are preliminary, and evaluation efforts are continuing.

A computer system such as WIS-SIM is not just a collection of computer software. It consists of inservice materials, documentation, operations procedures, and user materials, in addition to the actual computer code. One important aspect of the evaluation focused upon the teacher inservice program. The inservice consisted of printed exercises (simulations), discussion items, instructional activities, a teacher handbook and evaluation materials. Significant gains were evidenced on the inservice tests of knowledge and understanding of WIS-SIM, across all participants in the inservice (155 teachers, principals and aides). A mean gain of 4.6 points was demonstrated on a 20 item test. For many teachers, this was their second inservice on the system. Perceptions of system utility were assessed through the single item: "Do you think that CMI (WIS-SIM) will be helpful to you in making instructional decisions?" Across the three schools from

which these data were collected, a significant difference was not noted. However, two of the three schools provided extremely positive responses to this question for both the pretest and the post test. The school which gave the least positive responses at pretest, increased significantly from pretest to post test. A significant positive increase was evidenced from pretest to post test on the item which asked teachers how they felt about the system.

System functioning is assessed continuously as the system is used. The try-out of the system, preceding the 1975-1977 pilot test, identified several limitations of the system as operating at that time. In line with the developmental nature of the project, revisions were made as they seemed justified and could be designed and coded. System functioning has stabilized greatly as compared with earlier years.

Turn-around time was assessed in terms of the amount of time it took from the teachers submission of a request to the time the teacher received a response, as well as the time between the submission of the request to the computer and the time it was returned to the teleprinter. Analysis indicated that instructional needs were not too demanding, in that a turn-around time of 12 hours, or overnight, was usually all that was required and this requirement was easily met. The turn-around requirements suggested that overnight batch processing, rather than interactive processing, might be feasible for the majority of requests. Occasional requests for faster turn-around were evidenced. Usually, these resulted from

revisions or updates of earlier requests, need for information concerning a particular student for parent conferences, or teachers forgetting to forward requests to the operator of the terminal.

System accesses provided an indication of system utilization. Considerable variation existed between schools in the number of accesses made. This variation is due to such factors as the way the schools were implementing their individualized program (e.g., how often they report student progress to parents or how often they regroup students), degree of expertise of the terminal operator, cost of phone lines, and system availability. System accesses averaged approximately 15 per week, per program, but for one school of approximately 600 students averaged 42 accesses in their reading program during the weeks sampled. Such demand, even for a school which requires a large number of accesses, suggests that a single teleprinter operating at 1200 Baud should be sufficient to handle several curricular programs. Schools with low level of access were grouping students infrequently.

Teachers were requested to comment on the usefulness of five major reports generated by the system. Teacher ratings established the following priority of report usefulness; from most useful to least useful, were the Instructional Grouping Recommendation-Summary (a report listing students who are ready to begin instruction on each of a set of objectives specified by the teacher), the Individual Performance Profile (a listing of an individual student's performance across a teacher specified list of objectives), the Unit Performance Profile (a listing of the performance of all students in an instructional unit across a set of teacher specified objectives-less detail is included on individual student performance than included in the individual profile), the Prerequisite Deficiency Report (a diagnostic listing of prerequisites not attained for those students not ready for instruction on a particular objective), and the Instructional Grouping Recommendation-Omissions (a listing of those students who were not ready for any of the objectives listed on the Instructional Grouping Recommendation-Summary). The total number of observations varied in response to each report format, but approximately 115 teachers answered each question. The scale used for teacher responses ranged from 1 (very useful) to 5 (not useful). The mean usefulness ratings ranged from 2.18 for the Instructional Grouping Recommendation - Summary (rated as the most useful report) to 2.76 for the Instructional Grouping Recommendation - Omissions (rated the least useful of the five reports). It should be noted however, that all reports were rated, on

the average, as being useful (having a mean less than 3.0).

Following the analysis of the teacher ratings of report usefulness, teachers were interviewed concerning the Instructional Grouping Recommendation - Omission report, in order to obtain their suggestions on how it might be improved. Teacher comments indicated that it's usefulness would be increased if, in addition to the student names listed on the report, some indication could be given as to those objectives the students were ready to begin, if they were not ready for any of those listed on the Instructional Grouping Recommendation-Summary. This report has been subsequently modified, and it is anticipated that a higher index of usefulness will result at the end of the current year of pilot testing.

A detailed study of system cost has been conducted, but it is not possible to generalize costs directly from one setting to another. A case study was conducted of WIS-SIM initialization in one of our pilot-test sites in one curricular area. Included were the costs of project staff time for pre-planning, inservice training, system initialization, and on-going field support for a school year, as well as the costs of materials, supplies, computer time and disk storage. Teacher and other school staff time for training were not included. Costs averaged \$10.69 per student for the first year. Costs would be less than half this for a second year. It is estimated from available data that computer costs would average about \$3.50 per year per student for years subsequent to the first. As would be anticipated computer costs varied greatly between schools, primarily because of differences in the usage of the system. The costs for high-usage schools would be slightly higher than \$3.50 per year per student and low-usage schools would average less than \$3.50.

Some achievement data were collected over the last several years, but unfortunately they were not helpful in ascertaining system effects. Standardized test data were not collected by schools at the same time of the year. The data concerning the number of objectives mastered each year is confounded with the initialization of the system for new students and the incremental addition of students to the use of the system over the period of the try-out and pilot test. One indicator of increase achievement, as measured by the number of objectives mastered, results from the coding of the overlap between the mathematics and science programs at one school. During a half year of marking objectives as mastered in one program when the same objective was mastered in the other program, resulted in an increase of .57 objectives per student, or roughly a 5%

increase in the number of objectives mastered. This figure may be misleading in that most of the overlap exists at the early grade levels and virtually none in the later grade levels, so larger percent increases would be evident in the earlier grades than the later grades. Additional overlap exists between the science and mathematics curricula and other curricula, for example the study skills portion of a reading program. It is estimated that carefully monitoring of curriculum overlap could result in a more than 20% increase in the number of basic skills objectives achieved in the primary age groups.

Even if significant differences were to be found in the number of objectives mastered or on standardized test scores, it would be impossible to attribute them to the implementation of WIS-SIM, since during the period of the pilot test, several other significant changes were being implemented in the school under study. The increase resulting from the monitoring of the overlay is, however, attributable directly to the implementation of the overlap capability in WIS-SIM.

Several changes in school operations were visible as a result of the implementation of WIS-SIM. Perhaps most evident was the establishment of a new role in all participating schools: that of the computer-terminal aides. This individual or these individuals were responsible for submitting teacher requests to the computer, updating data bases, and receiving reports generated by the computer. Each school also identified an individual who supervised the operation of WIS-SIM in their school. One school had a full-time project director for this function; he was supported, however, out of ESEA Title III funds, in conjunction with a project related to the development and implementation of WIS-SIM in that school. It is estimated that supervision of WIS-SIM operations in a school requires a one-eighth to one-quarter time supervisor. The supervisor could be the principal, a teacher, a curricular specialist or an extremely capable aide.

Teachers, too, reported changes in the way they spent their time. An objective of the project, that the system would allow teachers more time in instruction and planning and less time in clerical activities. The data were collected over a two-week period in November and December 1974, April and May, 1975 and April and May, 1976 from four pilot test schools. Planning time for all staff, across all schools, was 29% in 1974, 29% in 1975 and 32% in 1976. Instructional time was 48% in 1974, 53% in 1975 and 50% in 1976. Finally, clerical activities consumed 23% of staff time in 1974, 18% in 1975 and 18% in 1976, a change of about 5% in three

years. The trend for teacher time allocation during these years was approximately the same as for all staff. Similar to student achievement, it cannot be established that these changes in the allocation of staff time were the result of the implementation of WIS-SIM, due to the large number of concurrent changes. Also the reliability and variability of these time estimates is not known; so the changes noted may or may not represent true differences.

Finally, teachers and other staff members were asked to express their feelings about the WIS-SIM implementation and its effects on their school. These reports were markedly divided. The reports of five of the schools were essentially very positive and those of the remaining two schools were essentially negative. The two schools with more negative responses were infrequent users of the system. The system apparently was not meeting their needs for instructional management. These schools were not implementing the Instructional Programming Model of Individually Guided Evaluation; they were not regularly grouping and regrouping students for instructional purposes and one school was very small. These two schools were essentially using the system for record keeping, but not as a management information system.

These areas which were viewed by school staff as being the most positive aspects of WIS-SIM were in meeting the needs of information management, improving comprehensiveness of the instructional program, assisting in the sequencing of instructional activities, helping teachers to meet individual student needs, improving student achievement, improving the quality of information, and not replacing the teacher in the instructional process.

The WIS-SIM is currently completing its second year of pilot testing in five Wisconsin schools. An evaluation plan similar to that outlined here continues to be implemented. Greater attention is being paid during the current year to student achievement, costs and how information generated by WIS-SIM is used in instructional decision-making. At the same time as the pilot test continues, the project is seeking a site where a large scale implementation of WIS-SIM can be conducted and studied. Additionally, a more generalized version of WIS-SIM, than that currently operational, has been designed and is in the process of being coded. It is anticipated that this system will also soon be pilot tested.

References

- Belt, Sidney L. and Dennis W. Spuck.
COMPUTER APPLICATIONS IN INDIVIDUALLY GUIDED EDUCATION: A COMPUTER-BASED SYSTEM FOR INSTRUCTIONAL MANAGEMENT (WIS-SIM), WORKING PAPER NO. 125 (Madison:Wisconsin Research and Development Center for Cognitive Learning, 1974).
- Klausmeier, Herbert J. ICE: AN ALTERNATIVE FORM OF SCHOOLING (Madison:Wisconsin Research and Development Center for Cognitive Learning, 1974).
- Spuck, Dennis W. "Computer Support for Instructional Decision Making in ICE." in Klausmeier, H. J., R. A. Rossmiller, and M. Saily, eds., INDIVIDUALLY GUIDED EDUCATION: CONCEPTS AND PRINCIPLES (New York: Academic Press, 1977).
- Spuck, Dennis W. "Evaluation for Effective Decision Making", in Lipham, J. M. and M. J. Fruth, eds., THE PRINCIPAL AND INDIVIDUALLY GUIDED EDUCATION (Reading, Massachusetts: Addison-Wesley, 1976).

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COMPUTER MANAGED INSTRUCTION
FOR INDIVIDUALIZED PROGRAMS

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ABSTRACT: The Computer Managed Instruction System has been developed to encourage maximum daily teacher-student contact in individualized programs.

A wide range of student reading capabilities, combined with the current student-teacher ratio in the Jackson Public Schools, in 1972, caused the management of individualized instruction to be an almost impossible task to accomplish within the normal time span of the school day. Recognizing this problem, the Superintendent of the Jackson Public Schools commissioned a committee including the Director of Data Processing, a Systems Analyst, and the District Supervisors of Reading, Mathematics, and English to investigate the possible utilization of a computer to assist in the management of the instructional program. A manual record-keeping procedure of student progress has been in use approximately four months prior to the formation of the committee.

Currently in its third year of funding, provided by Title III ESEA under the administration of the State of Mississippi Department of Education, the Computer Managed Instructional system (CMI) has been developed to encourage maximum daily teacher-student contact by handling major record-keeping tasks including all student progress tracking and almost eighty-five percent of reading test scoring. Two years before this funding became available, a reading continuum consisting of one thousand (1,000) behavioral objectives, ranging from primer through advanced sixth grade, had been developed with accompanying pre-test packets, which are, for the most part, self-directing and contain a pre-test and three treatments, post-tests which contain no more than fifteen objective test items, and limited resources for each objective. The resources were later tailored to the individual schools by using the Fountain Valley Teaching Support System for Reading.

The Diagnostic test is a series of objective reading tests designed to aid the teacher in placing the student on the appropriate continuum level and to prescribe specific skills to be mastered. There is a separate test for each of the ten levels of the continuum. Each Diagnostic test contains five sections, called Global concepts, which include: word analysis/phonetic, word analysis/structural, vocabulary, comprehension, and study skills.

With computer management a terminal is

placed in the classroom to track the individual student's progress, grade diagnostic reading tests and post-tests. To initiate the procedure, the teacher administers the diagnostic test to each student at their reading performance level. The student then takes his completed answer sheet to the terminal for grading. The teacher's aid keys the student's answers on the terminal and then transmits them to the computer. The test is graded by the computer and a prescription for the first objective the student needs to master is returned to the terminal to be printed. Objectives mastered using the diagnostic test will not be assigned to the student by the computer.

The prescription printed for each pupil consists of four parts with the first part containing the student's name, date of birth, and an identifying character string. The second part contains the behavioral objective and continuum packet number the student is to master, while part three contains the list of resource materials, including specific page numbers, that a student may choose to obtain the skills necessary to master the objective. The fourth part is the answer blocks for the post-test.

When the student thinks he has accomplished the objective, he takes the post-test for the objective and places his answers in the answer blocks on the prescription. The prescription is then returned to the terminal operator where the post-test answers are entered into the computer. The computer scores the post-test and determines the next objective to be assigned that was not mastered using the diagnostic test. This process is repeated until all objectives in the level have been mastered. When objectives covered by a diagnostic test are finished, the student is assigned the diagnostic test for the next level rather than the next objective. After completion and scoring of the newly assigned level test, the student returns to the normal cycle of mastering individual objectives.

Failure of a post-test brings the student the assignment of the same objective with resources different from those assigned the previous time if available. The second failure provides the student with the same assignment containing

the message "Take this assignment to your teacher". This requires the teacher to give the student additional assistance in mastering the objective. Teachers may optionally elect to bypass an objective when it is to the advantage of the student.

Additional advantages not found in the manual system include: (1) the ability to determine number of days a student has worked on a prescription, (2) replacement of lost prescriptions, (3) selective listing of students showing their names and current objective, (4) list of resources for an objective with the ability to add, delete, or change resources, plus the ability to change answers to post-tests, and (5) change answers for diagnostic test questions. Of course, students may be added, deleted, or student information on the file may be modified as needed. A report is provided weekly for the teacher indicating individual student progress within a level showing whether the objective was accomplished by post-test or diagnostic test answers.

The overall system is rather simple in design with four files being required. The current status file contains the student name, flags for the 1,000 objectives, date of birth, student identification number, and class assignment number. The history file contains a record for a student each time he successfully accomplishes a post-test. The master objective file contains all objectives, corresponding resources for each objective and post-test answers for each objective plus the acceptable score required to pass the post-test. The diagnostic test file contains the answers for each diagnostic test question plus the corresponding objective (s) for each question.

This year, a second school was added and with inadequate documentation the school came under the program with no major effort and has served to improve the program thus proving that the system is very simple to install and use. With this addition, the total number of students using this Computer Managed Instruction system is in excess of four hundred and seventy (470) students.

For those interested in equipment, twin IBM 370-155 computers using 3705 front-end processors under CICS were configured for the CMI system with Bell Dataspeed 40/2 KDP terminals with printers utilizing 2400 Baud lines have been used. It is also of interest to note that this was the first known use of this model terminal in the Nation in the Elementary School environment.

Examples of the Computer Managed System output have been included to provide additional information.

STUDENT PRESCRIPTION

XXXXXX JOHNSON GROUP 32 111999010021012149
 INITIAL - 2 2-1-018
 GINN, READING 360, 1970
 HELICOPTERS AND GINGERBREAD P. T187
 HARCOURT, BOOKMARK READING PROG., 1970
 SUN AND SHADOW (P) P. T217
 SCI RESEARCH, SRA READ PROG., 1964, 1970
 A HEN IN A FOX'S DEN (B) P. T49
 SCOTT, FORESMAN, NEW BASIC RD., 1963, 1965
 MORE FUN WITH OUR FRIENDS (1) P. T50
 SCOTT, FORESMAN, OPEN HIGHWAYS, 1968
 READY TO ROLL (P) P. T43
 1 2 3 4 5 6 7 8 9 10

STUDENT STATUS LIST

NAME	ID	OBJ	DAYS	LVL
XXXXXX SMITH	771025	0765	1	5-1
" SUMMERS	771026	0078	7 **	2-2
" WALTON	771027	0041	9 **	2-1
" WEBSTER	771028	0299	1	3-1
" WILSON	771030	0575	1	4-1

RESOURCES FOR THE OBJECTIVE INITIAL-V

INITIAL - V 2-1-017
 FIELD EDUC., FIELD READ SKILLS PROG., 1972
 TARGET YELLOW SHEET 5 P. T20
 HARCOURT, BOOKMARK READING PROG., 1970
 HAPPY MORNING, MAGIC AFTERNOON P., T66
 HOFFMAN ELEC. CORP., LANGUAGE ARTS PROG.
 STUDY UNIT 101-15
 IMPERIAL INT., AUDITORY DISCRIMINATION
 LOCATION RK-1 (16)
 IMPERIAL INT., INTERMEDIATE READING
 LOCATION I-2, 3
 IMPERIAL INT., PRIMARY READING
 LOCATION 22

COMPUTER SCIENCE AT THE SECONDARY SCHOOL LEVEL

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The integration of computer science into high school curricula from 1960 to the present is reviewed. A questionnaire was sent to the 214 largest high schools in Massachusetts and Northern New Jersey to determine the current status of efforts in this direction. The results indicate that although acceptance of computers in secondary education has grown immensely there are three major problems: lack of funding, student disinterest and few teachers that can use computers effectively. A suggested high school curriculum is presented which can alleviate these problems.

INTRODUCTION

There is no doubt that the use of computers has had a tremendous impact on the society in which we live. Intelligent utilization of this ever-increasing resource can only be accomplished by offering education about computers to everyone, especially students. Less than twenty-five years ago very few colleges or universities offered computer science or application courses. Now such courses are necessities, and there are hundreds of computer science degree programs. (26) This decade has even seen the beginning of integration of computer science into the secondary school curriculum.

One of the first large-scale experimental projects in the introduction of computer science to a high school curriculum was initiated in the fall of 1960. It took place in Montgomery County of Maryland and was sponsored by the Washington, D.C., Chapter of the Association for Computing Machinery (A.C.M.). One extracurricular computer course was offered to top students with the proper requirements. The course, titled "Introduction to High-Speed Digital Computation I," was taught in fifteen lessons and included guest lecturers by leading authorities on scientific and business applications. This is a summary of the lesson plan:

Lesson No.	Topic
1	<u>Introduction</u> . Background on history of computers. What a computer is, analog and digital computers, use of computers in scientific and business areas.
2	<u>Number Systems</u> . Decimal,

3	binary, octal and their use. Conversions from one system to another. <u>Basic Concepts of a Computer</u> . General description of a computer, specific discussion on computer components: input, output, arithmetic unit, storage, control. Exhibit of such devices, use of desk calculators and card punch equipment, if available.
4-5	<u>Analysis of Problems</u> . Logical and flow-chart analysis of typical problems, needs for such analysis.
6-13	<u>Programming a Computer</u> . The language of a computer, instructing a computer to solve a problem, demonstration and use of a computer.
14-15	<u>Applications of Computers</u> . Data processing: use of computers in business applications. Scientific computing: satellite tracking, design of missiles, war gaming. Language translation, automatic programming. Other applications and future developments in the computer area. (17)

The initial effort was quite successful and the program was expanded with each subsequent term. By the end of the second year there were six course offerings and the students had demonstrated great ability to do the work. Among the original contributions made by students were: a small computer designed by a 17-year-old student, simulation of a two's complement computer on an IBM 1620 and a neural net-

work simulation which was accepted for presentation at the 1961 Eastern Joint Computer Conference. The A.C.M. members proved that the secondary school level was not too early to introduce topics in computer science.

This and other pioneer efforts paved the way for secondary school computer science or application courses, but the growth was slow. The cost of computers at that time was very high and qualified teachers were in demand and not available for the wages offered to high school teachers. The sixties were a time of great development for college computer science programs but similar development was only possible at the secondary school level through special grants. About 1970 many of the prohibitory factors began to disappear. Project opportunities were numerous, mostly using minicomputers (some of the projects were sponsored by the manufacturers). A list of the major experiments of the five-year period around 1970's is:

Project Local	1967
Dartmouth Project	1967
Learning Research and Development Center	1969
Computing and Mathematics Curriculum Project	1970
Huntington Project	1970
Project Solo	1971
Project Logo	1971
Ties Project	1971
Project Reart	1971
Project Delta	1972

A survey by the American Institute for Research made for the National Science Foundation in 1970 showed that 12.9% of the public high schools reporting were using computers in some way in their instructional program.(7) That same year the first outline guide for high school teachers by the International Federation for Information Processing was published. It was titled Computer Education in Secondary Schools. In the introduction to the guide William F. Atchison says, "There is a need for all students to understand something about the nature and uses of computers in modern society. Only by having an informed and rational view of the way in which the computer is changing society and affecting the individual can future citizens be aware of the successes and dangers of the introduction of these new machines. Because of this importance it is essential that teachers of all subjects should have a knowledge of computing."(8)

The seventies emerging as the decade during which secondary school curriculums are altered to accept computers. In Getting Started in Classroom Computing, David Ahl gives the following as objectives of teaching about and with computers in the secondary school (2).

"To develop student appreciation of the computer's role in society;

To remove the mystery and bewilderment that may exist in the student's mind about computers and automation;

To enrich existing programs through use of the computer, allow student to work on creative and complex problems that would be impossible to solve by manual methods;

To motivate students and teachers to more individual, challenging instruction;

To develop the student's abstract reasoning ability and general problem-solving skills; to teach him algorithmic thinking and explore rigorous thought processes;

To encourage students to apply computer concepts creatively to a variety of application areas;

To better prepare college-bound students with an understanding of the computer and how it can and cannot be used to solve problems;

To provide students with vocational training in computer technology."

RESULTS OF A SCHOOL SURVEY

More than fifteen years of projects have demonstrated that students can learn and benefit from the knowledge of computers. In recent years many schools have instituted computer science or application courses on their own. How well are these programs working? What sort of curriculums are they using? What are the problems? An extensive survey of secondary schools was made to gather information about the secondary schools offering computer science or application courses. Finding a list of high schools offering computer courses was practically impossible (the State Boards of Education in New Jersey and Massachusetts were contacted and neither have nor know of any), so a group of most likely schools was surveyed.

The 100 largest (by student population) public high schools in eastern Massachusetts were all found to have greater than 1400 students.(20) There are 114 public high schools in northern New Jersey with more than 1400 students.(13) So, these 214 schools were selected and sent a questionnaire. Northern New Jersey and eastern Massachusetts were chosen because of their relatively high level of modern industrialization. A copy of the questionnaire and the accompanying letter are included as Figure 1. Questionnaires and letters were sent out to all the schools' respective Mathematics Department Heads on March 10, 1976.

The object of any survey is to determine the greatest amount of information from the highest percentage of people surveyed. There are two opposing factors in choosing a questionnaire. If the questionnaire is too demanding, few will respond. If the questionnaire is easy to respond to, many will reply but with minimal informa-

tion. Finding the optimal mixture is a complex and largely intuitive process. Added incentives for the return of questionnaire were the promise of a summary and an inclusion of a stamped, self-addressed envelope. The survey was most successful; 103 responses were received (48.1%). This degree of cooperation is itself indicative of the importance of this topic to high school mathematics departments.

Of the responses, 84.5% indicated that they did offer computer science or application courses, (which again was much higher than expected.) This sampling, of course, is not intended to be a good representation of all public high schools because of the area and population biases. However, it can be compared to a 1974 study which showed the percentages of "Instructional Computer Usage (Non-CAI) (9) to average better than 38% for the larger school districts. This is a striking increase.

Another interesting result was the response to question 4 ("What level of schooling should elementary computer science or application courses first be offered?"). Everyone (except for two "no opinion" answers) indicated that elementary computer science or applications courses should first be offered prior to high school graduation (as low as third grade). This certainly reflects a universal attitude toward computer education. A general breakdown is as follows: elementary (17), junior high (27) and high (57). Within these categories the responses were not as specific, giving many varieties of reasons for choosing their particular level. Mastering the concept of a variable was the most common intellectual level that was associated with programming, although it was thought to occur anywhere from grade three to Algebra I in high school.

Over half of the schools responding use BASIC as the introductory programming language, with many offering other languages for advanced students. The complete list of languages with the number of schools offering each one is BASIC (55), FORTRAN (10), RPG (8), Assembly Language (no specific type) (7), FOCAL (5), PAL (3), and APL (2).

Interpretation of the rest of the answers is more effective if the responses are divided into five categories. The categories are increasing levels of computer science integration into the general curriculum. Group 1 is for schools offering no computer courses, Group 2 schools offer one, Group 3 schools offer two and Group 4 schools offer three or more. Group 5 is for schools offering no specific number of formal courses, but which have integrated computer work into other traditional areas of study.

Group 1 - No computer courses offered - 16 (15.5%). Fifteen of these schools cited budget limitations as the major

reason for the lack of computer science or application courses. The other one said, "Administrative inertia supercedes financial consideration in blocking efforts to expand the program or even institute it in the high schools of the city" (Jersey City, New Jersey). Perhaps many of these other schools also suffer from lack of interest and the absence of funds is just a by-product. Only 5 of these 16 schools do not foresee any computer courses in the future. One of these had previously offered courses, but these had been cancelled for financial reasons. The locations of these schools were not concentrated in cities or any other particular type of geographic area, as might be expected.

Group 2 - One computer course offered - 35 (34.0%). The titles of the courses are: Computer Programming (17), Computer Math (9), Computer Science (3), Computer Theory (2), Computer Concepts (2), Data Processing (1), and Computers (1). Eight of the schools' math departments own computers: PDP-8 (4), Wang 2200 (3) and DDP-116 (1). Of the other 27 schools: 10 time share, 5 share a machine with the business department, 3 share with one other school, 3 use only programmable calculators, 2 rent batch processing time, 2 share a machine with many local schools, 1 rents an IBM 1130 and 1 uses no machine at all. The average number of students per year is 30.

Thirty students in a school of over 1400 (some of them way over 1400) is a small percentage (2%); the reach of these courses is very low. Six of the 35 schools reported no budget problems, but one teacher reported that she spent only \$1,000 per year for 70 students. She taught the course for nothing and drove the cards to batch process them each night (batch cost was \$1,000 per year). The other 29 schools indicated enormously, limited budgets, forcing many teachers to either teach this extra course on a voluntary basis or to drop it. There is no doubt that much of the lack of interest is caused by the insufficient funds. One school wrote, "Our computer was donated, no money is ever available to expand the facility. The course was written by faculty with no additional money for developing curriculums."

Five of the schools, however, seem to be doing well. Their future plans are to integrate computers in all math courses, and perhaps into science and others as well. Twenty other schools also indicated future optimism, but only modest additions of courses and/or hardware. Of the 10 other schools in Group 2, there is no further expansion in sight.

Group 3 - Two computer courses - 26 (25.2%). The courses fall roughly into four categories: Programming and Computer Math (10), both Programming Courses (7), Computer Science and Data Processing (6) and both Computer Science Courses (3).

Twelve schools own computers: PDP-8 (4), PDP-11 (2), IBM 1130 (2), Interdata 7/16 (1), Honeywell 120 (1), Wang 3300 (1) and one school owns both a PDP-8 and an IBM 1130. Ten schools time-share, 2 rent batch-processing time, 1 rents a Wang 2200 and 1 shares a machine with the business department. The average number of students per course year is 31 (the minimum is 6, the maximum is 125).

Polarization is the characteristic of this group. Half of the responses rate the success of the courses only moderate to poor, while the other half consider the success outstanding. The diversity of class sizes also correlates to the division. The respondents indicating problems with money and student interest suffer from the same problems as the majority of Group 2. Ten of the 26, on the other hand, have no budget problems. Nine of those schools plan to integrate computer studies into math and perhaps science and/or other fields as well. Except for 5, all of the rest plan modest expansions of their programs.

Group 4 - Three or more computer courses offered - 19 (18.4%). Ten of the schools offer 3 courses, five offer 4 and four offer 5. They are mostly programming computer math or data processing courses. Fifteen of the schools own computers: PDP-8 (7), IBM 1130 (5), PDP-11 (2), and Wang 2200 (1). Three schools rent batch-processing time and one other time-shares. The average number of students per course year is 27 (the minimum is 6, the maximum is 120).

Despite the small average class size, all the responses indicate that the courses are a success. All but six schools indicated that they have financial difficulties. Many problems in this group probably result from the number of staffing required for the various courses. Twelve of the 19 schools plan to integrate computer use into math, sciences and other areas in the future.

Group 5 - Computer use integrated into mathematics - 7 (6.8%). All of these schools have a curriculum in which students are directly exposed to the computer. Algebra II in all of these schools involves programming. One of the schools includes programming in all of its mathematics courses: "Computer Science is taught in every math class. Each student must write and run two programs in each of four marking periods. Difficulty of programming and mathematics increases with each year."

All but one of these schools have financial problems (the remaining one has a grant), but future plans call for continuation or future expansion.

The curriculums within this group are close to ideal and specific courses in computer science are available to most interested students. However, all students are exposed to the use and operations of computers.

PROBLEMS OF INTEGRATING COMPUTERS INTO SCHOOLS

Although the acceptance of computers in secondary education has grown immensely, there are still many unsolved problems. The two most predominant problems cited on the survey were lack of money and student disinterest. A third problem was that computer integration cannot be attained until more teachers can use computers effectively.

Most teachers cannot program and are unaware of the potential of the computer. There are two solutions used by many schools. First, the existing faculties are offering a course in BASIC (the most widely used programming language in high schools). BASIC can usually be mastered in a short time. A teacher is then more inclined to utilize one of the commercially available BASIC programs (simulations, games, etc.) that are offered as instructional aids. Another solution is for schools to consider programming experience more seriously as a criteria in hiring a new teacher. This has already become an important ingredient in the job market for mathematics teachers.

Another problem in attaining the goal of computer integration into secondary schools is lack of student interest. Most of the schools that indicated only poor to moderate success attributed it to this problem. There were no such indications in Group 5, a few in Group 4, but increasingly more in Groups 3 and 2. This seems to indicate that student interest in computers increases with greater exposure. Some of the courses in schools with low student interest face the possibility of being cut, which would seriously diminish computer exposure. Clubs are an effective and inexpensive way to stimulate student interest in the use of computers. The ACM is one of many organizations that supports club activities by supplying (at a minimal fee) information on how to set up and run a club, as well as how to obtain films, publications and other materials of interest. Extracurricular activities are discussed further in a succeeding section.

According to the survey, lack of money is another (perhaps the largest) hindering factor. The use of computers is still considered an extravagance, so it is not surprising that the first cuts occur in the computing budget. Because of this insecurity, many schools prefer not to purchase a machine.

The least inexpensive way to use a computer is to run on a locally available batch processing machine. This usually entails having to deliver card decks to the site as well as enduring slow turnaround time. From a student's point of view, the slow and frustrating process does not demonstrate the real speed and advantage of using computers. From a teacher's point of view, driving decks of cards around is a chore and a marginally

successful course could be destroyed.

Another way to get computer time without renting or buying a machine (an investment that scares school boards) is to tie into a time-sharing service. Renting or buying teletypes can be done economically and the students can communicate with distant computers by the public switch network. Ten of the schools surveyed use a Hewlett-Packard 2000 time-sharing service and are satisfied with the results. Their principle advantages are in the freedom from computer maintenance and eventual obsolescence that they provide. Where large amounts of computer time are employed, however, time-sharing is more expensive than owning or leasing a computer.

About half the schools surveyed that did offer computer courses owned computers. PDP-8, IBM 1130, Wang 2200, and PDP-11 machines were the most popular of these owned computers. Digital Equipment Corporation (DEC) machines (PDP-8, PDP-11) accounted for 30% of all the computers used. DEC's own 1974 estimate of their share of the school computer (interactive instructional usage) market was 60%. (18) Some reasons for their success is that the mini-computers are inexpensive and that DEC has several education systems (EduSystems) that can be tailored to any school's need or budget. The systems all utilize BASIC (some run other languages as well) and offer excellent software and curricular support. There are now several companies that supply alternative educational software exclusively Digital Equipment Corporation hardware, which highlights DEC machines as the de facto standard in education. All of the EduSystems are based on either a PDP-8 or a PDP-11 central processing unit and range in cost from \$6,000 to \$180,000.

SUGGESTIONS FOR A HIGH SCHOOL COMPUTER CURRICULUM

What is the typical curriculum for a secondary school program in computers? The survey indicates that most schools have chosen to introduce courses through their mathematics departments. Once the students (and faculty) gain proficiency with the computer, the curriculum can be expanded to take in all other areas. The type of implementation of the courses is crucial.

In a Curriculum Guide for a School Computer Program in Mathematics (18), G.A. Higgins, Jr. outlines different approaches to the introduction of programming and the use of computing in classical areas of secondary school study. Based on four of his approaches, a complete curriculum that is both comprehensive and adaptive can be created.

Mini-Courses are an excellent way to introduce students to programming. Large schools can offer hands-on introductory

courses by dividing a normal class size into many sections, each taking a two or three week mini-course. These courses could be included as part of another course, such as Introductory Algebra.

Topic Orientation is the key to integrating computers into all subjects. The computer is used only when an application can better demonstrate the subject matter. This will teach the proper use of computers as well as strengthen programming skills. Simulations are effective ways to demonstrate topics like: genetic inheritance, effects of controls on insect populations, enzyme lock and key action or business competition. In mathematics, approximating the roots of an equation or numerical integration could be done by the student with much more understanding. Topic orientation is the only way to reach the students who might normally never use a computer.

Computer Science or Application Courses are a necessary part of any school curriculum. Topics can include advanced programming, logic design or even computer games. These courses are designed for the students who enjoy working with computers to see if they might like a career in the field.

Extracurricular Activity is a logical completion to any academic program, but especially so with computer work. Students can work at their own pace, either jointly or individually, on scientific and mathematic investigations. These projects may be done as a term project for a course or as part of a computer club activity.

The ACM has established a computer club program for high school students. The objectives of the computer clubs are "to stimulate interest in computer-related activities and to make known the importance of computers to the future of every high school student. (1) Each club must be sponsored by both a school faculty advisor and an ACM local or student chapter representative. The student dues are two dollars per year. In return, the ACM sends books and articles, suggests activities and lends films, publications and other materials.

These four types of courses can be used in any combination, depending on the needs and resources, to develop a curriculum in computers for any school.

CONCLUSION

We are now finishing the second decade of computers in high schools. Computer Science and computer applications courses already play an important part in a number of high school curriculums, although they are not integrated into most programs. Trends indicate that the current goals of all high schools offering these courses are towards more complete service and general integration. In addition, many more

high schools will begin to offer computer science and computer application courses as more support, experienced teachers and computers at low cost become available. The impact of computers and data processing education in the high school will be profound in the coming years.

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BIBLIOGRAPHY

1. Association for Computing Machinery, A.C.M. Computer Club Information Brochure, New York.
2. Ahl, David H., Getting Started in Classroom Computing, 1974, Digital Equipment Corporation, Maynard, MA.
3. Ahl, David H., 101 BASIC Computer Games, 1975, Digital Equipment Corporation, Maynard, MA.
4. Albrecht, Robert L., Population, A Self-Teaching BASIC Primer, Digital Equipment Corporation.
5. Allison, Ronald, Problems for Computer Mathematics, Digital Equipment Corporation, Maynard, MA.
6. Bushnell, Don D., The Computer in American Education, 1967, John Wiley and Sons, Inc., New York.
7. Bussel, Claudia, Computer Education for Development, 1972, Ao Livro Tecnico S.A., Guanabara, Brazil.
8. International Federation for Information Processing, Computer Education in Secondary Schools, 1970, Amsterdam.
9. Digital Equipment Corporation, Computers are for Kids, 1974, Maynard, MA.
10. Digital Equipment Corporation, Curriculum Material Product Catalogue, 1975, Maynard, MA.
11. Communications of the A.C.M., "Curriculum 68," March 1968, II, 3, 151-154.
12. De Vries, D.S., and Edwards, K.J., "Learning Games and Student Teams: Their Effects on Classroom Process," 1973, American Education Research Journal, 10, 307-318.
13. State of New Jersey Department of Education, Directory of Approved New Jersey Secondary Schools 1975-76, 1975, Trenton, N.J.
14. Digital Equipment Corporation, Education Product Catalogue, 1974, Maynard, MA.
15. Edwards, K.J., De Vries, D.S., and Snyder, J.P., "Games and Teams: A Winning Combination," 1972, Simulation and Games, 3, 247-269.
16. Ellsworth, PH., A Short Course in BASIC, Digital Equipment Corporation, Maynard, MA.
17. Heller, George G., "A Computer Curriculum for the High School," May 1962, Datamation Magazine.
18. Higgins, G. Albert, Jr., A Curriculum

- Guide for a School Computer Program in Mathematics, 1974, Digital Equipment Corporation, Maynard, MA.
19. Kernan, Thomas A., "Computers and Education," April 1964, Communications of the A.C.M., 7, 4, 205-209.
 20. Department of Education, Massachusetts School Directory 1974-75, 1974, Boston, MA.
 21. Minsky, Marvin, "Form and Content in Computer Science," April 1970, Journal of the A.C.M., 17, 2, 197-215.
 22. Slagle, James R., The Hueristic Programming Approach, 1971, McGraw-Hill, Inc. New York.
 23. Digital Equipment Corporation, Understanding Mathematics and Logic Using BASIC Computer Games, 1975, Maynard, MA.
 24. van der Aa, A.J., Computers and Education, 1970, Science Associates/International, Inc., New York.
 25. Wodarski, J.S., Hamblin, RL., Buckhardt, D. and Ferritor, D., "Effects of Individual and Group Contingencies on Arithmetic Performance," January 1971. Paper presented at the meeting of the American Educational Research Association, New York.

Figure 1

Name			
School			
Town			
1. What computer science or application courses are offered at the school? If none, skip to question 4.			
Title/Description	Machine	Language	Avg. #
	Used		of
			* Stu-
			* dents
2. In your opinion, how successful have these courses been?			
3. How is computer time managed? (i.e., Do you rent time-sharing time?, Own/rent your own machine?, Share a computer with the Business Dept.? etc.).			
4. In your opinion, what level of schooling should elementary computer science or application courses first be offered? Please explain why.			
5. How much of a factor do budget considerations play in getting computer science or application courses into the school?			
6. What are the future plans for the school curriculum in regard to computer science or application courses?			

COMPUTER SUPPORT FOR A SYSTEMS APPROACH TO INSTRUCTION

PROBLEM STATEMENT AND DATA ENTRY TECHNIQUES

by Eugene A. Collins and Dean C. Larsen

The Jefferson County Public Schools is conducting a study which implements a digital time-shared computer as support for a systems approach to instruction. This study presently involves one elementary school but it will support a total of 13 schools in the future. The computer support includes computer generated criterion test forms. The items for the test forms are randomly selected from a test-item bank. Additional computer support includes the use of a remote document reader for test scoring and updating student academic records. The records are updated using test results and teacher certification of mastery. Data from academic records is being studied to determine its usefulness for formation of instructional groups in a multi-unit elementary school. Alternative reports to assist teachers with the formation of student groups for instruction are being printed. Teacher behavior with these reports is being studied in order to optimize the report's usefulness in instructional processes. The effects on teachers's roles caused by the computer support of an existing instructional system are being observed.

Many programs for individualizing education have been developed during the last ten years. An outcome of these experiences has been the identification of a problem which is common to all attempts to individualize. The problem is one of data management. At any given time students in a particular group may be at many different places in the curriculum, each student in the group having different learning needs. Information about the learning needs of each individual is usually available. However, techniques have not been developed for effectively managing this information for optimizing the instruction for each student.

This paper is a description of a National Science Foundation¹ project located in The Jefferson County Public Schools, Jefferson County, Colorado. The project is designed to develop computer support for an existing instructional management information system in schools attempting to individualize instruction. The primary purpose of the project is to develop the data management techniques required to group students with similar learning needs.

The Jefferson County Public School District has defined curriculum in language arts, mathematics, and reading by stating explicit student performance objectives. Procedures for monitoring student progress against these objectives

have been identified. The programs have been implemented through grade 8. In mathematics, criterion test items have been developed parallel to the objectives. Levels of mastery have been established. Dependency hierarchies between objectives have been identified, and multiple learning activities have been designed which relate to these objectives.

Teachers are keeping records on individual student performance against the objectives. However, these records on individual student performance are not generally used as a basis for selecting appropriate learning activities. Furthermore, in most schools, the formation of student groups for instruction is not accomplished through the use of past performance records. That is to say that student records are not widely used as input into the formation of groups of students for instruction or into the design of instructional strategies. As a result, effective grouping of students for experience with appropriate learning activities does not always occur. Students may be provided instruction in skills which they have previously mastered or for which they do not have the necessary prerequisite behaviors.

While systematic diagnosis of student's individual needs may occur, this diagnostic information is not always available in a useable form when students are grouped for instruction. This is due primarily to the fact that instructional decision makers have too much data. They do not have the procedures nor the time necessary to process it.

The project described here is developing a solution to this problem. Funded by The National Science Foundation Office of Experimental Projects and Programs, Experimental Programs Group, the project is titled The Computer Support for a

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Systems Approach to Instruction. A computer system which will allow instructional decision makers to process records on student performance is presently being developed. The outcome of the application of this system will be the formation of student groups for instruction.

The system is being developed on a Hewlett-Packard 2000 series time-shared computer. Communication and remote data entry are handled over telephone lines with a General Electric Terminus 300 terminal and a Bell and Howell Mark Document Reader.

Development is taking place at Normandy Elementary School. After refinement and field testing the system will be installed in a total of eleven schools in the Bear Creek/Columbine Area of Jefferson County. These schools will be added in two waves over a period of four years after the system implementation is completed in the development school.

The system is being developed in a manner which will provide for the maintenance of performance information on children in any discipline. Currently, mathematics performance records of students in the development school are being managed on the computer. Four years of performance history are being maintained on each individual. In order to insure that these performance records are current, two system components for updating them have been developed. The first component provides update by application of criterion referenced testing for mastery. The second component allows update by teacher certification.

When teachers are interested in testing students over any subset of objectives, in mathematics, they call for a test using the test generation subsystem. This subsystem generates a recipe for the test by randomly selecting items for each objective from an item bank. The item bank contains approximately 80 multiple choice items. The recipe produced by the computer lists the items to be used on the test, the order in which they are to appear, and the correct answer. Multiple choice items are listed first followed by items requiring more detailed student responses. This recipe is used by an aide who constructs the test by drawing items from the item bank.

The decision has been made to use only two test items per objective. The criteria for mastery is that both items must be answered correctly.

The test is administered to students. They respond to multiple choice items on an answer card shown in figure 1. Students respond to non-multiple choice items on their test paper. These non-multiple choice items are then graded and transcribed to the answer card by an adult. An answer key is filled out from the test recipe. This key is entered through the mark document reader along with the student answer cards. Grading of the test is done by computer. The student's academic performance records are automatically updated by the system. A summary of test results is printed out for teacher analysis.

The advantages of this procedure are numerous. First of all, there is total flexibility regarding which objectives are tested together. Random selection of items from the bank is also assured. More than one form of each test can be generated, and there is no need for computer storage of the answer keys. Automated grading and record update is provided along with enough human interface to allow for non-multiple choice items.

A second component of the system allows for update of student records through teacher observation and subsequent certification of mastery. This is a necessary component of the system because many mathematics objectives through the second grade are not appropriately measured using paper and pencil. Student behavior described by these objectives includes verbal response and application of manipulative devices. These behaviors must be observed and recorded by the teacher. Furthermore, this teacher observation and certification is an appropriate assessment of student behavior beyond second grade.

The need to update records by teacher observation and certification is being supported by the form shown in figure 2. The form is initially blank on the left side. The heading, containing student name, system number, mathematics level, etc., is printed by the terminal. Forms for each student in a particular group are kept together in a folder. Teachers observe individual student behavior. Mastery of particular objectives is then certified by marking the appropriate code on the computer readable part of the form on the right side. These forms are read periodically by the mark document reader which has the capability of reading both $3\frac{1}{4}$ " and $8\frac{1}{2}$ " width forms. Student records are updated accordingly.

As mentioned before, the form in figure 2 is initially blank on the left side. Alternative types of individual student profiles are being printed remotely by the terminal in this space. The project staff and teachers are working together to determine which forms of the individual student profiles are most helpful to the teachers in supporting their efforts in observing students.

Now that many of the mass data entry problems have been solved, the primary task of the project is being pursued. The task is to increase the useability of the data for teachers who use it to form instructional groups. The development school, as well as many of the other project schools, is implementing Individually Guided Education. Under this model, schools are organized on a multi-unit basis. Each unit is composed of 100 to 150 students with up to three years age difference. The formation of such multi-age units increases the heterogeneity of the unit with regard to student's previous background and experience. This increased variety enriches the learning experience which can be brought to any instructional subgroup formed within the unit. This heterogeneity is important to learning in any discipline.

Within a multi-age unit, instructional subgroups are formed in the skill disciplines on the basis of common, student learning need. These skill disciplines are typically mathematics, reading, and language arts. Based on their observations and previous experience with students, teachers identify clusters of objectives for which they think instruction is needed. Student's needs with regard to these objectives are assessed. If instruction is needed, appropriate student groups are formed.

The multi-age unit organization along with the procedure for subgrouping on the basis of skill needs has the following advantages. Some of the heterogeneity present in the total unit is maintained in the instructional subgroups. Furthermore, variability in student achievement in any subgroup is reduced. This allows the opportunity for planning an optimal learning experience for each subgroup.

Student learning needs related to any cluster of objectives in mathematics are assessed in two ways, through diagnostic test procedures and through the analysis of historical records of student performance.

When a team of teachers feels the need to regroup within their unit, the objectives for potential instruction, during the next instructional period, are identified. A pretest is constructed over prerequisite objectives using items from the test item bank. The test is administered and graded. A computer analysis of the pretest results is then executed. This analysis produces a diagnostically ordered relation between all examinees and a similar ordering of objectives.

The Group Diagnostic Report which results is a matrix where each row represents an individual student profile over the objectives tested. Each column represents the tested groups mastery profile over an individual objective. The rows have been sorted to produce the diagnostic ordering of students. Each student with the same mastery profile is in the same position in the order. Students with similar mastery profiles are close to each other in the order.

The columns of the matrix have also been sorted to produce a diagnostic order in the objectives. Each objective with the same set of students mastering it is in the same position in the order. Objectives with similar sets of student masters are close to each other in the order. A sample Group Diagnostic Report is shown in figure 3.

The usefulness of this report in the formation of student groups is now being studied. In addition a study is being conducted to correlate the diagnostic ordering of students produced by pretest data with the diagnostic ordering of students produced by historical mastery data from previous years. This study is designed to determine whether or not equivalent diagnostic ordering can be produced from historical mastery data thus eliminating the need to pretest and thereby saving instructional time.

Any successful application of computer technology to support instruction requires attention to the interface problems which exist between the user system and the technical system. The level of technical literacy on the part of educators is of primary concern. They need enough technical literacy to understand both the power and limitations of the computer and to communicate precisely with it. The required level of technical literacy may be different for each educator. This depends on the educator's role in the schools and the person's relation to the information system. These various roles and relations must be observed. The necessary level of technical literacy must be identified and provided.

The problem of understanding and precisely modeling the users original information system is of equal importance. Technical staff members must recognize their role as one of modeling the users information system rather than redesigning it to meet some external constraints. Only if a precise computer model is produced will meaningful computer service be provided.

These interface problems are much more severe than generally recognized. They are solved only through well planned procedures which increase person to person communication. In order to increase person to person communication, the project has chosen the procedure of on-site development and slow expansion to other schools over a period of several years.

INSTRUCTIONAL DATA PROCESSING:
PERSPECTIVES AND GUIDEPOSTS FOR THE
Nontechnical User

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The past and present growth rate of educational computing is examined with particular attention given to instructional computing. Implications for future growth are drawn from the available statistics. The paper is developed with the nontechnical user in mind -- such as the typical teacher, curriculum coordinator or school administrator. Specific and concrete suggestions are made, answering such questions as: "How can a teacher learn more about existing or feasible computer resources in his/her school district?" and "What are some suggestions for instructional computing in different subjects and for different grade levels?"

Electronic data processing is a technological phenomenon of very recent origin, having had a massive impact on the institutional processes of our schools--first in the business management areas of administration¹ and subsequently on our schools' instructional,² guidance³ and library processes.⁴ The current pervasive influence of EDP on education is the consequence of dramatic changes in the way we have processed various types of information following the introduction of UNIVAC I (the first commercially available modern electronic computer) twenty-five years ago.⁵ Computers have advanced at an incredible rate since that time, becoming over 1000 times faster, much smaller in size and weight, more accurate and comparatively cheaper.⁶ Also, the number and specific types of program routines they now provide is vastly improved. The result has been an impressive increase in use and accessibility by a widening range and number of people in education--specialists, administrators, guidance counselors, librarians, teachers and students.

A recent survey jointly sponsored by the American Institute for Research and National Science Foundation⁷ involving 6,000 randomly selected secondary schools (which represents 25% of the national total) established that in 1975, 52.7% of all related schools were using computers in the administration of the school, and/or in direct support of the instructional program. A similar study conducted by the same groups five years earlier, in 1970, showed that 34.4% of all secondary schools were using EDP. This represents a change in usership in five years of from over 1/3 to over 1/2 of all of the potential secondary school users in the United States (an approximate 50% increase). However this same period of time reflects a

period of general fiscal retrenchment in schools, and a search for greater efficiency and cost benefit. Moreover, there were no significant new federal grants or program fundings during this period which could explain this dramatic national growth in so short a period of time--an expansion even more significant within the context of an increasingly conservative fiscal climate in which we all find ourselves.

As with many school innovations, the EDP usage in our schools derived its impetus from without educational institutions⁸--primarily from successful business practices--and so our schools came to use computers about five to ten years after similarly sized and complex businesses did. The benefits of using EDP for all types of business activity were impressive--computers were quicker, more accurate and usually much cheaper than the alternatives. Since school computer use is primarily locally funded, it logically follows from the results of the mentioned survey that the growth of computers in secondary education is highly related to the demonstrated benefits that the frequently large investment will bring to the school system. Because the use of EDP in education has followed the lead of business and industry, it is not surprising that the primary use of EDP in schools yet today is in the general area of administrative applications.

TABLE 1 Secondary School Survey⁹

	1970	1975
Using Computers	34.4%	52.7%
Administrative Use Only	21.5%	29.5%
Instructional Use Only	3.9%	4.5%
Both Administrative and Instructional Use	9.0%	18.7%
Non Users	65.6%	47.3%
	100.0%	100.0%

In 1975 schools using EDP, for administrative uses

only, was 29.5% with an additional 18.7% using EDP for both administrative and instructional applications. An additional, small, 4.5% of all secondary schools used EDP for instructional purposes only--and where this is the case, there usually is some special purpose state or federal grant money encouraging the improvement of some aspect of the instructional program amenable to the use of EDP (as is the case in the Hempstead, Long Island schools today). However, the overall increase in the use of EDP for instructional purposes (a 79.8% increase) seems to be the most dramatic of all of the statistics presented, since those schools using EDP for both administrative and instructional purposes more than doubled (over 107% increase) in the five year period between 1970 and 1975 (an increase of from 9.0% to 18.7%). This contrasts with the significant but less dramatic percentage increases in overall users (an approximate 53% increase) and users for administrative purposes only (an approximate 37% increase).

TABLE 2 Secondary School Survey:
Computer Usage Increases

	1970	1975	Percent Increase Over 1970 Level
Secondary Schools Using Computers	34.4%	52.7%	52.8%
Both Administrative and Instructional Use	9.0%	18.7%	107.8%
Instructional Use of Any Type	12.9%	23.2%	79.8%
Administrative Use of Any Type	30.5%	48.2%	58.0%
Administrative Use Only	21.5%	29.5%	37.2%
Instructional Use Only	3.9%	4.5%	15.6%

Figures obtained during the months since the study cited indicate that this trend continues. A current, specific example of the continually expanding EDP use in education is St. John's University, where the capacity of the university owned EDP equipment has more than doubled during the past year, while overall enrollment has not increased (and in the Graduate School and College of Education even sharply decreased). This dramatic increase in EDP capacity was and is significantly affected by increasing instructional and academic research demands.¹¹

Even the most conservative of the informed forecasters of the use of EDP in education predict both its continuance and growth. The major disagreement concerns itself with the rate of future growth. Based on the current social and fiscal environment in which schools find themselves, there probably will be a moderating although continuing increase in the use of EDP in schools. Armed with these facts, an educator is well advised to concern himself or herself, not

with the "to have or not to have" issue, but rather with the concern for increasing an understanding of what the "blackbox"¹² called a computer is and is not, and with what the proper uses as well as misuses of computers¹³ in education are.

General School and School District Computing Considerations

Unless a particular school building has a large enrollment or some unusual, justifying program, computers tend to be acquired on a school district basis, servicing both the administrative and instructional needs of all of the schools in the district. This centralization of the computer's central hardware--i.e., the computer's central processing unit (CPU) and related peripheral equipment--is justified because: a) the cost of a medium to large size computer is usually too great for a single school, and b) the other alternative of acquiring a number of minicomputers for each separate school would not provide the same range of computer problem solving capability nor likely be as economical on a student (or other) contact hour cost basis. Since each separate school in a district under a shared arrangement can have its own school-based user input/output terminals for student and teacher use, there are comparatively few disadvantages. Some possible disadvantages might include: a) excessive long distance telephone costs (as remote terminals are connected to the central computer via a special telephone line arrangement) for widely scattered schools, and b) the need for on-site computer hardware for certain specialized computer science courses. These two problems can be minimized by locating the computer in the school with greatest probable use.

A centralized district-wide electronic data processing (EDP) system can enable the hiring of a more expert technical staff than would be possible on a school by school basis. However, if such a staff handles both administrative and instructional applications, great care must be taken to insure through both the organizational chart and in day-to-day practice that the computer related instructional needs of the school district are serviced on par with the district's administrative needs. The failure to resolve this inherent conflict has resulted in at least one major university maintaining two distinct electronic data processing systems--one for administrative purposes and one for instructional uses. The resource limitations of most elementary/secondary school systems, however, do not allow them this option without seriously delimiting their functional data processing capabilities in each of the two mentioned areas.

Nevertheless, an increasing number of schools and school systems are purchasing a wide variety of minicomputers, largely to function where no computer capability existed before. Frequently such purchases represent the initial computer usage for the school, and the choice of such equipment is based largely on a lower required initial cash commitment by the school. In many cases, the purchase of a minicomputer by a school is viewed

by its personnel as the only feasible alternative to having no computer at all. But since the owning or leasing of any computer represents an expenditure of from several thousand dollars per year (in the case of minicomputers) to many multiples of it, careful, expert review should be given to the matter prior to any institutional commitment. Computer manufacturers are many--including Digital Equipment Corporation, Hewlett-Packard, Honeywell, International Business Machines--and are quite ready to send a representative to discuss a school district's computing needs in terms of what they as a computer equipment supplier have to offer. Their specific hardware and software packages as well as pricing arrangements vary widely and are constantly in flux. To a lesser extent the variance in service available from a given company from geographic area to area is also an important factor to consider before deciding on a specific EDP system purchase.

Most importantly, of course, are the software capabilities of the system selected--that is that part of the product which furnishes specific computer language and programs to meet the specific application needs of the school. Relatedly, questions to be asked might include: Is there a pre-programmed computer assisted instructional program available in mathematics for elementary grades one through eight? What are its comparative strengths and weaknesses in the overall market? Is it compatible or can it be made compatible with the curriculum and curriculum materials which our school system has planned to use? If not, is it feasible and proper for us to modify that curriculum? Does the computer hardware/software package lend itself to teacher and student programming for special school-specific computer science and physical science coursework needs? If so, are the computer languages in its compilers sufficient (BASIC? FORTRAN? COBOL?)? Is the size of this specific computer (i.e., the size of its main memory in terms of characters of storage) adequate for the school's essential current needs and the school's probable needs for several years? On the other hand, is the school system justified in purchasing or leasing a large computer such as an IBM 360 or 370?

These and other questions like them must be articulated and answered if the best possible educational decisions are to be reached. Because of the complex and technical nature of many of the questions, and all of the related answers, and because individual computer hardware and software firms have an understandably biased viewpoint, many school systems turn to an outside consultant to aid them in their selection of an EDP system package. It is money well spent. Such a person, to be useful, must have an expert knowledge of both: a) educational needs and processes (administrative, instructional, guidance, etc.) and b) the technology of EDP hardware and software. This person needs to be expert in both areas if the requisite articulation between the school system's personnel (who must establish all instructional specifications) and the computer industry's personnel (who will furnish information on the technical capabilities of their products and their costs is to take place. In the absence of such a consultant, the selection of a computer

is frequently determined in the direction of the most capable salesman, rather than on the comparative objective merits of the competing EDP systems themselves.

Preliminary investigations into what is possible, feasible and effective in the realm of instructional computing can be accomplished in several ways. First, a teacher can inquire of his or her school district office of an instructional computer usage which might exist in the same school district, and then arrange to visit it, preferably during a period of actual student usage. On such a visit, an informal chat with the teachers involved will provide very useful insights. A visiting teacher might ask if he/she can sit at an available terminal and work through a student exercise or two.

If such is not yet operational in your own district, you might inquire into what preliminary research and planning has been done in your own district in this regard. (Shame on the school district central office staff which hasn't done at least that much! Fortunately, they are becoming increasingly fewer.) A teacher or curriculum supervisor from a school system not yet in possession of its own instructional computing capability may want to arrange visits to preferably several systems which have such a capability.

Another source of both information and actual instructional computing capability for your school district is your area Board of Cooperative Educational Services (BOCES). Many of their central purposes lend themselves readily to computer applications. As an example, the Nassau County BOCES, largest in the state of New York, has not just one, but several, computers and a wide array of administrative, guidance and instructional computer application packages. Many of these applications are available to the school systems within Nassau County at a favorable rate, as each BOCES operation receives substantial state subsidy. This approach might be desirable for those school systems not yet ready to procure their own EDP system, but yet desirous of improving their own instructional and/or administrative processes through the advances in computing technology. A BOCES or other cooperative type arrangement might also be advantageous in the instance where a more specialized or advanced application is not available and/or cost-wise not feasible within a school district's own EDP system. This might occur in certain areas of computer assisted instruction for certain groups of exceptional children, or in areas of computer assisted career guidance programs, or in yet other specialized domains.

Instructional Computing

The instructional use of the computer occurs throughout the United States at the elementary, secondary and postsecondary levels. However, the exact shape and extent of its use varies from grade to grade and from subject to subject, as do most instructional innovations. At the elementary level, the two subjects most frequently assisted by instructional computer routines are mathematics and the language/reading areas, and a wide array of pre-programmed packages are commercially available in these subject areas. Thus, they seem an

appropriate entry point for an elementary school to begin its own instructional computing activities. Probably the best way for elementary school curriculum planners to proceed into computer assisted instruction activity for the first time is to seriously consider several of the commercially available computer assisted instruction (CAI) software packages on the market. (For purposes of this presentation, a separate discussion of the less highly evolved computer managed instruction--CMI--approach will be set aside, in the interest of brevity.) Some of the current leaders in computer assisted instruction software materials for the elementary school include Univac, Hewlett Packard, Computer Curriculum Corporation and others. It must be remembered that CAI is a special application area, maintaining its own product identity, and it does not necessarily follow that the leading manufacturers of computer hardware will also be the leading producers of computer assisted instruction software materials.

A specific example of an elementary school level CAI application might be useful. Through a combination of local and state monies, the Hempstead, Long Island, New York schools recently purchased a Computer Curriculum Corporation CAI package. This program was originally created by Professor Patrick Suppes of Stanford University.¹⁴ This particular version has three basic programs relating to the three basic elementary subject areas of mathematics (grades 1-8), language arts (grades 3-6) and reading (grades 3-6). Additionally, each of these subject areas are comprised of "strands". Included in the grades 1-8 mathematics area CAI program, for example, are the following fourteen strands: number concepts, horizontal addition, horizontal subtraction, vertical addition, vertical subtraction, equations, measurement, horizontal multiplication, laws of arithmetic, vertical multiplication, division, fractions, decimals and negative numbers. Each of these strands contains material appropriate to several or all grade levels. Once the student is initially oriented to the keyboard method of entering his/her input/response (a process completed in less than a half-hour), she/he interacts with the computer in a question and answer fashion truly remarkable to those uninitiated to the capabilities of CAI. The computer's response is automatically typed on a roll of paper which the student can take home as evidence of his/her achievement. Also available, but less popular because it is more costly and does not furnish transportable feedback, is the cathode ray tube type display computer feedback. It is similar to a TV screen with the print occurring in the picture tube area. In the CAI program being described, the computer questions and subsequently responds to the student in a variety of sentence structures from natural English usage, and addresses her/him using her/his own given name (which the student initially gave to the computer when beginning her/his sequence for the day). The computer presents a variety of individualized problem tasks to the student in common language (printed) from each strand at the appropriate grade level, the grade level of each task being adjusted strand by strand on the basis of that student's prior performance in each strand. The computer is programmed to also keep track of each student's performance each day,

in each subject area attempted, and in each distinct strand. This report is available to the teachers as output on a student by student, class by class and/or on a school wide basis, and in combination on a daily, weekly, grading period or yearly report basis. This computer managed instruction (record keeping) aspect of the program is a feature useful to the curriculum planning of individual teachers, grade and subject matter supervisors, and to the related planning activity done by key school administrators.

On the human side, students typically react very favorably to this truly individualized type of instructional mode, which includes drill and practice, tutorial and dialogue-type instructional features. The student gets immediate feedback. He is advanced through constantly varied, but soundly structured, curriculum exercises compatible with most standard elementary texts and curriculums. The pace set for him by the CAI program is automatically adjusted, strand by strand, to his quickness and achievement level. The student does not risk embarrassment in front of his peers or teacher. The shy and sensitive are not penalized. Self-concepts are left intact and they grow.

A teacher or teacher aide is available in the terminal room to provide direction when requested or needed, and to provide that fully human contact and encouragement that is needed from time to time by every student, and needed constantly by a few. This particular CAI system can interact simultaneously with several dozen students, typically responding to each student's distinct input in no more than a second or two. It is literally impossible for any one teacher to individualize instruction at this pace, so well. With a minimal amount of preventative maintenance, the computing system will perform reliably in this manner, day after day, week after week throughout the school year. It does not take coffee breaks, get sick, get impatient or moody with students, and does not forget to do its lesson plans. It does all of this individualization on about fifty cents per hour per student. It is as if the classroom teacher had several dozen highly qualified teacher-aides at her/his service for one-on-one tutoring duty. How the computer accomplishes all of this involves a highly technical explanation which the teacher need not be concerned with unless the teacher wishes to pursue this topic as an extra curricular interest.¹⁵

Highly refined CAI programs are also available at the secondary and postsecondary level. Since subject matter becomes increasingly more diversified, specialized and complex as it moves up the educational ladder, and since teachers of these subjects relatedly specialize their interests and focus more sharply on their own curricular interests, it becomes more frequently the case that a particular teacher may desire to program his own tutorial/instructional routines for his own particular subject. Admittedly, to be fully satisfying for the teacher so inclined, a great investment in hardware, software and peripheral devices must be made by the school, and the teacher must also acquire special programming skills not required in the use of a commercially prepared CAI

program similar to the one described.

Seldom, if ever, do locally prepared programs become as highly refined as the one described--as one school or one teacher does not have the time, nor resources necessary for such an accomplishment. However, many useful and valuable custom-made routines have been so created throughout this county, enhancing instructional modalities and student learning. One typical example of this can be found in the Sewanhaka Central High School in Floral Park, Long Island. In that school a number of creative instructional routines have been developed by its own school personnel in such subject areas as mathematics, social studies, biology, chemistry, physics and computer science. Among large city school systems in the United States, the School District of Philadelphia has one of the most well developed instructional computing programs. An interested reader might want to contact these and other school systems currently using instructional computing for additional, useful information.

In general, the following subject areas at the secondary level most intensively use instructional computing of some variety: computer science, mathematics, business education, and physical science. Depending largely on teacher interest, instructional applications are also found with some frequency in the social sciences and language arts (English, reading) as well as in other assorted subject areas.¹⁶

It is reasonably argued by many that the computer does not teach in the fullest human sense, at least as CAI is presently conceived. This is probably true, and it may always be true that there will be matters of discourse on values, and qualitative issues of richness and hue not easily reducible to the quantifiable coding required for computer assisted instruction. That point granted--and a great many teachers thereby feeling less threatened--it is equally true that the computer can now handle a wide variety of very important instructional duties which could otherwise only be performed by a human teacher. This, combined with the computer's unique capabilities and an increasingly favorable cost/performance factor, form the basis for very favorable bicentennial prospects for the future use of computers in education.

Footnotes

¹Judith Murphy, School Scheduling by Computer: The story of Gasp (New York: Educational Facilities Laboratories, 1964); Robert W. Marker, Peter P. McGraw, and Franklin D. Stone, eds., Computer Concepts and Educational Administration (Iowa City, Iowa: Educational Information Center, 1966); Stephen J. Knezevich, ed., Administrative Technology and the School Executive (Washington, D.C.: American Association of School Administrators, 1969); and Gary M. Andrew and Ronald E. Moir, Information-Decision Systems in Education (Itasca, Illinois: F. E. Peacock, 1970).
²Stephen J. Knezevich, ed., Instructional Technology and the School Administrator (Washington, D.C.: American Association of School Administrators, 1970); Patrick Suppes and Max Jarman, "Computer-Assisted Instruction," The Bulletin of the National Association of Secondary School Principals 54

(February 1970): 27-40; Warren J. Koch, The Use of Computers in Instruction in Secondary Schools (Washington, D.C.: National Association of Secondary School Principals, 1972); B. Hunter et al., Learning Alternatives in U.S. Education: Where Student and Computer Meet (Englewood Cliffs, N.J.: Educational Technology Publications, 1975); and James R. Okey and Kenneth Majer, "Individual and Small-Group Learning with Computer-Assisted Instruction," AV Communication Review 24 (Spring 1976): 79-86.

³U.S. Department of Health, Education and Welfare: Office of Education, Computer-based Vocational Guidance Systems (Washington, D.C.: U.S. Government Printing Office, 1969); Donald Super, ed., Computer-assisted Counseling (New York: Teachers College Press, 1970); and Allan B. Ellis, The Use and Misuse of Computers in Education (New York: McGraw-Hill, 1974), pp. 121-161.

⁴Robert M. Hayes and Joseph Becker, Handbook of Data Processing for Libraries, 2nd ed. (Los Angeles: Melville Publishing Company, 1974).

⁵Khateeb M. Hussain, Development of Information Systems for Education (Englewood Cliffs, N.J.: Prentice-Hall, 1973); Anthony G. Oettinger, Run, Computer, Run (Cambridge: Harvard University Press, 1969); and Van Court Hare, Jr., Systems Analysis: A Diagnostic Approach (New York: Harcourt, Brace & World, 1967).

⁶Elias M. Awad and Data Processing Management Association, Automatic Data Processing: Principles and Procedures, 3rd ed. (Englewood Cliffs, N.J.: Prentice-Hall, 1973), pp. 34-40; and Division of Instructional Systems of the School District of Philadelphia, Layman's Guide to the Use of Computers (Washington, D.C.: The Association for Educational Data Systems, 1971), pp. 2.00-2.02.

⁷Arthur L. Korotkin, William J. Bukoski, and American Institutes for Research, "Computer Applications in Secondary Education," in The Association for Educational Data Systems, AEDS Proceedings (Virginia Beach, Virginia: Better Impressions, 1975), pp. 1-2.

⁸Robert G. Owens, Organizational Behavior in Schools (Englewood Cliffs, N.J.: Prentice-Hall, 1970), p. 149.

⁹These tabulated statistics are derived from the article by Korotkin, Bukowski, and AIR, "Computer Applications," AEDS Proceedings, p. 2.

¹⁰These tabulated statistics are interpolated from the article by Korotkin, Bukowski, and Air, "Computer Applications," AEDS Proceedings, p. 2.

¹¹The writer of this article is an official member of the St. John's University Computer Committee, teaches graduate data processing for educators courses, advises doctoral dissertation use of the computer, and utilizes the facility for his own academic research.

¹²Hussain, Information Systems, pp. 14-17.

¹³Ellis, Computers in Education.

¹⁴Suppes and Jerman, "Computer-Assisted Instruction," The Bulletin of NASSP, pp. 27-40.

¹⁵Awad, and DPMA, Automatic Data Processing; and Wan H. Kim and Henry E. Meadows, Jr., Modern Network Analysis (New York: John Wiley & Sons, 1971).

¹⁶William Bukoski and Arthur L. Korotkin, "Computing Activities in Secondary Education," Educational Technology 16 (January 1976): 9-23.

NEW FROM NORTHWEST REGIONAL EDUCATIONAL LABORATORY
TRAINING MATERIALS FOR TEACHERS AND ADMINISTRATORS

Judith B. Edwards, Ph.D.
Northwest Regional Educational Laboratory

Northwest Regional Educational Laboratory is currently publishing two new sets of instructional materials. The first is designed to prepare elementary and secondary teachers to select and use computer-related instructional applications. Included is material on computer hardware and software, the various roles played by the computer in instruction, how to select computer-related applications, and a set of readings on computer use in several different curriculum areas. Also included are several exemplary application units. The second set of materials is designed for practicing and potential educational administrators. It provides hands-on experience in the uses of the techniques of operations research in management and administration, through interaction with several programs and supporting instructional materials.

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A continuing obstacle to implementation of computer applications is the lack of "computer literacy" on the part of teachers and administrators. The Computer Technology Program (formerly REACT) at Northwest Regional Educational Laboratory has addressed this problem through development of training materials since 1969.

The most recent training materials are now being published by the Laboratory, to be available in early summer, 1977. These new materials have two primary

purposes: 1) to prepare novice teachers to evaluate and select appropriate computer-based instructional applications and 2) to prepare administrators to use the computer together with the techniques and tools of operations research as an aid in decision-making.

Computer Applications in Instruction: A Teacher's Guide to Selection and Use

To often our teacher training programs give teachers a thorough grounding in computer programming techniques, debugging, and sometimes even hardware operation--only to then leave them marooned on an island of technical competence, still asking, "But how do I use the computer in Social Studies...?" (or Biology, Geometry, Music, Art, P.E., English, Business Education, Language Arts, Home Economics, and so on.)

This "Teacher's Guide" addresses the question in several ways: first, through a collection of readings on computer applications in eleven areas of the curriculum from agriculture to zoology, plus applications for the deaf and hard of hearing and elementary school applications. These readings provide a survey of the "state of the art" in most subject areas a teacher might wish to explore. Another section deals with the several uses of the computer in instruction, and presents as illustrations many examples of programs currently available. Twelve of the most common applications of the computer in the instructional setting are explored, including some of the newest uses in guidance and in generating

instructional materials. While the twelve uses of the computer discussed here do not exhaust the available approaches to computers in this continually developing and changing field, it focuses on the most fundamental and frequently encountered applications today.

As a means of systematizing this presentation, these twelve applications have been grouped into five basic categories of computer use in instruction, centering on the use of the computer as:

1. An instructor/teacher
2. A laboratory
3. A calculator
4. An instructor/teacher's aide
5. An object of instruction

Thus, a teacher can compare the style and content of the interaction in a drill-and-practice program with that in a simulation or data analysis program, and can relate these applications to computer-managed instruction or the teaching of computer science as a discipline in its own right.

Finally, the teacher is given guidelines and exercises for evaluating and selecting appropriate computer applications for use in his or her own classroom. The materials stop short of preparing a teacher as a developer of computer applications. However, teachers who have been trained with the materials are better prepared to specify what it is they want to a programmer or curriculum consultant. Many also become developers--although the attempt with these materials is to produce literate computer users rather than skilled instructional designers.

Three complete "sample applications" are included to provide real examples of carefully-developed computer based applications for instruction. One is a simulation of the U. S. energy crisis, another a set of problem-solving and discovery exercises in mathematics, and one is a simulation of the urban crime problem.

It was discovered in field testing that one could not assume that the potential audience for the materials was already "literate" about computer hardware, software and programming, nor that such literacy was desired. Nevertheless, a certain basic level of understanding of computer concepts and vocabulary was

prerequisite to optimum use of the materials. To this end, another section has been included, to provide a background in the essential hardware/software/programming concepts. During field testing of the materials in Minnesota, teachers used various combinations of the topics covered, to meet their particular backgrounds and needs.

Ideally, a computer system would be available for teachers to access sample programs during training. The three exemplary programs, ENERGY, FUNCTIONS, and CRIMEX could be used for this purpose, or a workshop leader could choose to rely on programs already available on their system.

The materials may be used in a variety of training settings. The short workshop of up to three days, a course meeting once each week for a couple of hours in the evening, or several Saturday sessions are equally effective. Teachers of varying backgrounds may participate in the training, by assigning sections of the materials appropriate to each teacher's level of expertise. Those with no previous exposure to computers may go through all the materials, while more experienced teachers may elect to study selected portions, perhaps supplemented by more actual programming. Upon completion of the course some participants will want to become developers as well as users, and may begin to write specifications for applications for their own classroom use.

Computer-Based Methods for Educational Decision Making: An Introduction and Guide for School Administrators

Among modern planning and decision making tools, the several techniques of operations research developed in the 1940's stand as some of the most powerful and versatile tools for management. Until recently, the complexity of computations underlying these techniques precluded their extensive use in educational administration. However, as computer computational support is becoming commonly available to educators, and the necessary computer programs are now readily obtained, operations research techniques are beginning to make their unique contribution to the modern educational administrator's battery of planning and decision-making tools.

The purpose of this book is to provide the educational administrator or planner with a working understanding of the most useful operations research techniques and experience in using computers to provide the background computations required by each. The emphasis throughout the text is on the practical application of the

techniques to real educational problems. The text presupposes only that the user has access to a computer: the use of computer programs and the interpretation of their results for decision-making are taught in the text, and all complex mathematical manipulations underlying the application of the techniques are left to the computer.

The approach used to present the techniques is practical and non-technical throughout. The book is intended to be useful for practicing school administrators, for students and professors of educational and business administration, and for educational planners at all levels of the educational enterprise. Evaluators will also find the book applicable to the problem of public accountability in expenditure of resources. The examples used are real problems faced by decision-makers in schools, and the computer programs demonstrate new and useful tools for solving such problems.

As managers in the enterprise of education, school administrators find decision making to be their primary activity. But how often do their decisions result in the best possible outcomes for the problems they face?

In many day-to-day educational problems, the alternative solutions are so clear and well-defined that the manager can intuitively decide which is the best solution. Many routine problems such as deciding which teachers to assign to lunch duty or deciding which of two new teachers to hire can be solved by well known and intuitive procedures. There are, however, many educational problems which are large and complex and have a great number of possible solutions. It is often very difficult to pick out intuitively the best solution from all the possible solutions to these problems, because the criteria for a best solution are not intuitively evident. It is precisely for such large, complex problems that the tools of operations research were designed.

One example of the complex problems that educational managers face is that of minimizing costs in all phases of education while maintaining or improving quality. For example, the administrator must typically make the decisions necessary to hold down the costs of the school lunch program while at the same time assuring that each child receives a nutritionally adequate meal. He or she must minimize the cost of buying new textbooks while at the same time making sure that the quality of instruction remains high. He or she must make the decisions required to negotiate teaching contracts while simultaneously

holding the line on costs and insuring adequate or improved instruction. Bus schedules must be constructed so all children are transported at a minimum cost. Building maintenance must be scheduled to minimize both cost and interference with instruction. It should be evident that arriving at solutions to problems of this type requires more than intuition.

Problems requiring simultaneous minimizing and maximizing of effects, such as those described above, are not the only type of complex problem that the administrator faces. Planning is another area in which large and complicated problems arise. In this area, the administrator faces such questions as: "How can a curriculum revision be carried out so that all the materials are ready by the start of school next year?" "How do I make sure that all the small tasks necessary to complete this revision get done in the right order and with a minimum of time wasted?" "What is the best sequence of activities for carrying out a revision of the administrative structure?" "What tasks have to be completed and in what sequence must they be done, in order for me to be ready for the upcoming salary negotiations?" "What is the best and most efficient way to carry out a needs-assessment study for my district?" "What are the activities and what is the sequence for preparing my school's budget for next year?" The solutions to such planning problems are generally beyond the scope of simple intuitive decision making.

In addition, the educational manager is often faced with problems of prediction. He or she must have some rational basis for answering such questions as, "How is the population in this district going to change over the next ten years? How many and what kinds of physical plant facilities will the district need in the future? How must the teaching staff change to meet expected enrollment changes? What new equipment must be purchased in order to meet the future needs of the students, faculty and community?"

For each of these complex problems, the number of possible solutions is quite large, but there are usually only a small number of solutions which will meet all of the criteria for a successful solution. That is, there are only a few solutions which will simultaneously minimize costs and maximize some other important variables (such as achievement), which will create the most efficient plan, or which will predict in the optimum manner. It is easy to see that these types of problems require more than intuition.

In all these educational administration problems, two things are required of the administrator: a decision must be made with regard to the solution to the problem

and the administrator must have tools beyond insight and intuition with which to work out the decision. Operations research techniques together with the computational ability of the computer provide some of these tools. All that is required for an understanding of the techniques is the willingness to use quantifiable data.

The operations research techniques presented in this book are PERT, linear programming, queueing theory, and simulation.

PERT provides a powerful methodology for analysis, planning, and communication in complex multi-step projects. For simple projects, a PERT network may easily be constructed by hand. Often, however, projects have a large number of activities and complex relationships among these activities. In fact, the greatest utility of PERT is in such large projects, which are difficult to handle with manual procedures. Fortunately, a number of computer programs exist which will efficiently solve large PERT network problems. This book introduces managers to one such program, which, from data supplied by the planner, provides durations of activities and earliest completion time as well as identifying which activities are on the "critical path." Users of the book interact with program to plan activities for such projects as preparing a budget request for an elementary school, polling the district teaching staff on their attitudes toward differentiated staffing, and conducting a school census.

Linear programming is useful in problems that involve allocating some resource in order to optimize (maximize or minimize) a certain result. An example of such a problem is achieving racially balanced schools while transporting students a minimum distance from their neighborhoods.

In this book, such problems are solved with the help of a computer program which provides an optimum solution given the existing constraints. In order to use the program, however, the manager must be willing to assign actual values to the many decision variables inherent in the problem. He or she must be willing to place quantifiable relative values on such intangibles as "quality of instruction" and "maximum possible benefit."

Queueing theory is a method for analyzing waiting line or queue problems, that is, problems in which there are one or more service facilities and where units of some kind require the services of these facilities at various times. Service facilities may include school lunch servers, film projectors, ditto machines, district maintenance departments, guidance counselors, examinations, learning packages, or teachers. The units of the queue or waiting line may be students, teachers, committees, typewriters, automobiles, school buildings,

and so forth. These units do not have to be physically waiting in line, but rather just requiring service by the facility. Queueing theory provides a mathematical description of the physical behavior of these waiting lines and facilities. This technique can tell us such things as what the average length of the waiting line is, how long a unit just arriving at the waiting line can expect to wait, and how much of the time the service facility is idle.

Queueing theory is, therefore, a valuable decision-making tool for the administrator concerned about efficient utilization of time and facilities. Some typical educational problems are posed in the book, and several computer programs are used to demonstrate their solution using queueing theory.

Finally, the book presents simulation as an operations research technique for formulating and operating models of problems. When we speak of model in this context we are referring to a representation of the problem which is simpler and easier to understand and manipulate than the real problem situation. For instance, a mathematical equation may be a model of a real system; a set of logical steps can be the model of a decision process. The principal value of a model of the administrator is that he or she can try out a number of different solutions to the problem on the model without taking the time or money that would be required if these solutions were tried out in the real decision context.

It should be noted that PERT, linear programming, and queueing theory are specialized types of simulation. PERT constructs a graphical model of a project. Linear programming develops mathematical equations which are a model of the problem. Queueing theory develops essentially a mathematical model of problem situations where there are customers waiting to use a service.

Simulation is a powerful technique for investigating a problem and providing information as to the ramifications of many alternate decisions. The book provides many examples, together with computer programs as "operating models" of the problem situation. The administrator may explore many alternative solutions with no risk or pressure, to help him or her decide on a strategy for solution.

The work of the Computer Technology Program in developing the two sets of materials was supported by a grant from the National Institute of Education. NIE has demonstrated a continuing commitment to the sponsoring of research which results in the improvement of education through the application of modern technology.

THE GUIDANCE INFORMATION SYSTEM: THE TOTAL APPROACH

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The Guidance Information System (GIS) is a computerized data retrieval system which provides instantaneous access to information about occupations, four- and two-year colleges, and financial aid. GIS is an interactive system designed for use by individuals in high schools, colleges, counseling centers, and public libraries. Among the topics to be discussed in this paper will be the procedures followed by an education service center to make GIS available to many school districts at a modest cost (through the use of time-sharing techniques) and the necessity of follow-up and in-service training.

The concept of Career Education has been nationally advocated as a means to more adequately prepare young people to cope with both the demands and choices they face in an environment undergoing extensive and rapid change.

Three of the key components of most Career Education programs focus on: increasing a person's self-awareness, increasing his/her understanding of lifestyles and career roles, and increasing his/her skill level in decision making and planning. Basic to each of these elements is the availability of sound information. Much of the responsibility for providing this information falls within the realm of school guidance personnel.

Recognizing the critical need to provide career information to students that is accurate, up-to-date, and readily accessible, forward looking guidance departments are reassessing not only the quantity and quality of the information available to their students, but also the manner in which the information is presented. The utility of traditional methods of presenting career information is being questioned and new techniques of accomplishing the objective are being sought. In an attempt to help the school districts serviced by the Region 10 Education Service Center (Richardson, Texas) deal with the problem of providing a viable career information dissemination system, several computer-based information delivery systems were investigated by the center's staff. After substantial evaluation of available systems, the Guidance Information System (GIS) was selected as the delivery vehicle.

The Guidance Information System is a computer-based system which provides instantaneous remote access to occupational, college, and financial aid data which is regularly up-dated and checked for accuracy. GIS traces its roots to a project conducted at Harvard University under the

direction of Dr. David Tiedemann. Since 1971 the system has been further developed by Time Share Corporation, a subsidiary of the Houghton Mifflin Company.

Ease of operation, flexibility, and a comprehensive data base were among the criteria used in selecting GIS as the career information delivery system for Region 10. The actual operation of GIS is really quite simple. A user can "communicate" through a terminal located in his/her own environment. Because GIS is available in a time-sharing format, numerous access terminals can be located in a variety of sites, some quite distant from the base computer. This feature makes it feasible for relatively small or remote school districts to access a comprehensive data source. The flexibility of the GIS is additionally enhanced by the option of adding locally gathered and up-dated information to the basic system.

GIS is structured in such a way as to allow its users to obtain both a broad spectrum of information on 1200 occupations, more than 2500 two and four year colleges, and a wide variety of financial aid sources. Individuals working with GIS use a Student Guide, which details characteristics about occupations or colleges, to select those items they want to include in their search. For instance, in the occupational file, a user might want to include one or more of the 15 job clusters identified by the U.S. Office of Education, certain aptitudes or interests usually related to a particular job, a particular level of education or training, etc. After a list of particular occupations has been identified by the computer, GIS allows a user to focus on any occupation to access additional information about that occupation: employment outlook, salary ranges, working conditions, physical demands, etc. The Student Guide is structured to provide initial broad organization to a GIS search while at the same time providing for great flexibility within that organization.

Not only does GIS supply large amounts of computer-based data, it also provides a special cross-referencing system which refers its users to other sources of career and college information. The referenced materials include sound film strips, kits, printed job briefs, and microfiche often found in career resource centers. GIS can thus form a hub for extensive career exploration and decision-making experiences and bring students into contact with a variety of information formats.

In essence, GIS makes it possible for a user to examine the ways in which his/her personal criteria for making decisions about occupations or colleges affects the range of options available. Because the instructions being given the computer can be modified at any point, GIS permits each user to see not only the results of one set of decisions, but, to change his/her mind and to explore the ramifications different choices would have. This flexibility of GIS greatly enhances its usefulness and makes it a viable counseling tool in the development of decision-making and planning skills. GIS closes the communication gap between the facts and those who need to use them for effective decision-making.

The remainder of this paper will focus on the actual process by which the Region 10 Education Service Center effectively implemented GIS in a variety of educational settings. Education Service Center, Region 10 has been providing computerized career information since 1972. In fall, 1974 ESC-10 piloted the Guidance Information System in 5 high schools and in spring 1975 decided to offer GIS as a service in its Instructional Computer Network. Ten high schools participated in the fall of 1975, all suburban schools with senior classes averaging 450 students.

The expansion of timeshared computer services in the area served by the North Texas Multi-Regional Processing Center in the spring of 1976 created increased demand for computerized counseling services in a variety of new environments. Where previously the GIS system had been used only in large urban/suburban high schools with 400-600 seniors each, now school districts with senior populations of 10-200 were expressing a strong desire for this kind of delivery system. Styles and methods of implementation had to be worked out to meet these needs at a reasonable cost and with minimum disruption to existing programs. A small pilot site where various delivery strategies could be tried was found in the spring of 1976 in order to determine the appropriateness of the GIS system in this new environment. Forney High School, Forney, Texas had been involved in career education planning through Education Service Center, Region 10 and learned of the Guidance Information System through one of ESC-10's career education consultants. Forney had one counselor, Ann McCord, who had responsibility for the entire K-12 guidance program for a district of 700 students, including 38 seniors. This usually meant dividing time between the elementary and high school buildings in an effort to reach all students personally. Ms. McCord's enthusiasm for GIS as a way to deliver needed information made Forney an ideal site for a pilot study. Since the counselor was only

present at the school part-time, it was important to train student personnel in GIS operation. Many other problems in implementation were discovered and solved. The district was in an outlying rural area, making a long distance call necessary to use the computer facility, so a certain amount of long distance time was made available by the Service Center. A computer terminal was selected with a balance taken between cost, reliability and portability. Training was important for Ms. McCord and the student aide, and just as important was a clear awareness on the part of school administrators of the purposes and procedures involved in using GIS. Training aids from Time Share Corporation were utilized for orientation and training. A film which relied heavily on counselor and administrative comments was used for awareness, along with news articles about other implementations. A filmstrip and Student Guide booklets were utilized in an intensive 3 hour session for the technical training necessary to operate the terminal and GIS program, most of which was on-line work with the computer system. Then the counselor and student aide were turned loose to discover the patterns and styles of usage which would be most successful in their setting. After two weeks of monitoring a follow-up visit was made. The district was enthusiastic. They had run out of the allotted telephone time and the district had authorized additional money to continue to dial-up the computer. The entire senior class had been served and others were involved with new and follow-up inquiries. Much of the usage was directed by the student aide, either because the counselor was at another building, or working one-to-one with students who had detailed questions about what they had discovered during their GIS searches. After another week at the school, the terminal was picked up and lengthy discussions were held to determine how the pilot had fared. Several determinations were made which seemed significant:

1. The need for career information retrieval was even more profound in the smaller school districts because of the lack of capital required to acquire traditional career education materials.
2. Professional guidance and counseling personnel could be more effectively utilized if technical and factual questions about occupations and colleges were handled by the student-run terminal.
3. Training in use of the terminal and computer system was no more difficult in the small rural setting than in the large, urban, so called "sophisticated" schools which already had terminals.
4. Interest and enthusiasm among students was extremely high, making the terminal a focus for greater awareness about career education in general.
5. Once professional personnel were aware of the usefulness of GIS within their existing setting, a modification of counseling style took place to better utilize the new resource.
6. The time required for effective utilization of GIS was roughly proportional to the number of students served, making possible the sharing of the computer terminal by a

number of schools, depending on size.

A plan was conceived to implement GIS in a variety of styles and environments, with particular emphasis on the small school. Since, depending on size, a given school district might utilize the computer terminal for a few weeks to several months, the concept of co-operatives was established. Each co-op for GIS would serve a particular area, typically an outlying county. A town was found in each area where direct telephone service to the computer center could be established. This flat rate "foreign exchange" service enabled the districts to make their computer calls at the lowest possible rate, in many cases without additional charge. School districts within the projected cooperative boundaries were invited to a presentation on GIS and its applicability to their particular district. The following method was used:

1. A Time Share filmstrip was used to introduce the GIS concept.
2. Sample searches and printouts from GIS were presented and discussed.
3. Emphasis was placed throughout on the objective, factual nature of the system, leaving the subjective, personal counseling where it belongs, in the hands of the professional.
4. If possible, a brief on-line demonstration was given, using questions from the counselors if not, a typical type of portable computer terminal was shown and its use discussed.
5. The presentation concluded with a discussion of the co-operative concept and some rough cost projections.

The sessions were extremely successful and an initial co-operative was selected to begin operation November, 1976. This was the Fannin County Career Education Co-operative, an already funded association of nine small school districts in Fannin County, centered on Bonham, Texas. District sizes ranged from 180 seniors in the largest district down to approximately 9 seniors in the smallest. Training on GIS was held for the two project consultants along with faculty and student representatives from each district. The project is now operational with GIS as one of its major components. Although the details of implementation and results of this project are beyond the scope of this paper, a complete report on the project should be available in April, 1977.

GIS has shown itself to be a highly effective, flexible tool for delivery of career information, which, as shown in this discussion, can be implemented in a variety of environments previously thought inappropriate to the use of computerized systems. School year 1977-78 promises to be a year of significant expansion, using principles outlined in this paper.

THE MICHIGAN OCCUPATIONAL INFORMATION SYSTEM

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Lawrence J. Molloy

In order to provide valid, current and reliable occupational and educational information to both students and adults, the Michigan Department of Education is acting as the administrative agent for the development and operation of the Michigan Occupational Information System. The system is unique as it was designed by its potential users for use on a wide variety of hardware-software configurations on regional or locally operated computer systems.

It has long been recognized that a need exists for both students and adults to have access to valid, current, and reliable occupational and educational information in order to make wise career decisions. Recognizing this problem, the U.S. Department of Labor has provided grant awards to eight states for the development of statewide occupational information systems. As Michigan was a recipient of one of the grant awards, the Michigan Department of Education is acting as the administrative agent for the development of the Michigan Occupational Information System (MOIS). The MOIS program is presently concentrating its efforts on developing reliable occupational and educational information based upon the following goals:

- A) Provide access to the information for a wide variety of users through one or more delivery systems;
- B) Develop a state and local information base that realistically reflects the employment and educational scene in Michigan;
- C) Create a data base and linkage system to meet the identified informational needs of user groups.

To accomplish these goals the MOIS staff has worked with several committees and interested individuals concerning the design of the MOIS package and the gathering and development of MOIS information.

MOIS Information Development

The current focus on information development for the MOIS program is aimed at providing data base components which reflect the occupational and educational

structure of Michigan's jobs and institutions. Data has been developed in six files:

- 1) Michigan Occupational File: The 1976-77 file contains information on 200 occupational titles that reflect 861 specific occupations. The 1977-78 file will contain 350 titles reflecting 1,150 specific occupational titles. Each occupational description includes information on the nature and duties of the job, working conditions and requirements, economic benefits and advancement, job outlook and additional sources of information. National, state, and regional figures are quoted in the wages and outlook sections.
- 2) Program File: This file contains information on 102 post-secondary programs offered in Michigan's public and private colleges and universities and private vocational schools.
- 3) School File: Michigan's two-year and 4-year colleges and universities and private vocational schools are described in this file.
- 4) Apprenticeship File: Forty apprenticeable trades are identified and described by their length, occupational field, what is learned on the job, and what is learned in the classroom.
- 5) Military File: Presents related military training opportunities for compatible MOIS occupations. The related training is identified by service, title, military rating, and major job duties.
- 6) School Subject File: This file identifies school subjects

desirable in preparing for the MOIS occupations.

For each data base a development and review process has been established for purposes of identifying information topics and validating occupational descriptions. This process involves the development of actual samples, an external review by knowledgeable individuals (including potential user groups), revision, development procedure documentation, and editing prior to final entry into the system.

MOIS Information Delivery

The vast usage of technology in schools in Michigan has created a need for alternative information delivery strategies. Over 1,200 microfiche readers were in schools prior to the development of MOIS. A microfiche based delivery component was developed for this large user group. Additionally, over 600 computer terminals were already located in K-12 school buildings and at colleges and universities. These terminals communicated with computer systems at either regional or local data centers. To serve the needs of the many schools that have access to computers, an interactive delivery system that could be locally or regionally installed was developed.

The Design of the MOIS Interactive System

Before selecting a model for the MOIS interactive system an analysis was made of systems already in use in Michigan. These included the Computerized Vocational Information System (CVIS), the Guidance Information System (GIS), the Educational Career Exploration System (ECES III) and the System of Interactive Guidance and Information (SIGI). In addition, the Career Information System (CIS) from Oregon was examined. The results of this study indicated that none of the systems were suitable for the MOIS interactive model in regards to:

- 1) cost effective computerized delivery vehicles.
- 2) system usage features.
- 3) information characteristics which are consistent with the purposes of an occupational information system.
- 4) the ability to be installed on a wide variety of computers in locally operated data centers.

Rather than attempting to "re-invent the wheel" MOIS met with representatives of local data centers and guidance personnel that had used various computerized guidance systems. After discussing both the results of the study and the goals of MOIS, it was recommended that two committees be established to design a system

that would be acceptable to users throughout the state. Each committee was composed of individuals who had experience with existing computerized guidance programs and who represented potential users of the new system. The first committee, whose backgrounds and areas of expertise were embedded in the fields of guidance and career education, was charged with the responsibility of recommending search strategies and information logic which could overcome most of the deficiencies in existing interactive guidance deliveries; and, in addition, be attractive to the multiplicity of user groups which MOIS must serve. The second group, whose composition reflects systems analysts and coordinators of various computer based/assisted instruction projects, was charged with the technical design and format for the program. Through the efforts of both committees, the following developmental standards, pertinent to the MOIS interactive component, were delineated:

- 1) User controlled
- 2) Easy to operate
- 3) Quick to provide information
- 4) Operational on a variety of computers
- 5) Operational on a variety of computer terminals
- 6) Cost effective

To implement these standards, MOIS called upon an experienced team of computer programmers from the Macomb Intermediate School District. The MOIS computer program being designed by this team characterizes MOIS standards and, in its final form, will be transportable to a variety of computer systems.

The MOIS Structured Search

Prior to accessing the system, participants can complete the "Personal Profile Inventory" contained in the MOIS User Handbook. This experience is designed to help users gain an insight into their personal career choices by stipulating their preferences for work with respect to the following occupationally significant variables:

- 1) An expressed interest toward work in terms of Data, People, and Things
- 2) Temperaments required for occupations
- 3) Strength levels required for occupations
- 4) Physical capabilities required for occupations
- 5) Working conditions required for occupations
- 6) Educational levels required for occupations

These six categories are answered at the terminal in a sequence determined by the user. After each answer, the terminal will print the number of occupations that have the desired selector. For example, if the user first selects an interest in data-people jobs, the terminal will say that 50 occupations contain that specific characteristic. If the second choice is a desire for a community college training program, the terminal will print that 9 of the 50 data-people occupations have related community college training programs. The user may continue this process until a list of occupations is desired. The terminal will print the title and MOIS catalog number of each remaining occupation. Should the user then request a reason why a particular occupation is not on the list, this routine is also available for use.

Additional MOIS Search Strategies

Beginning in the fall of 1977, MOIS users will be able to access the system through a variety of standardized approaches. These include: 1) the "Ohio Vocational Interest Survey" (OVIS); 2) Holland's "Self Directed Search" (SDS); 3) the "Differential Aptitude Test" (DAT); and major occupational clustering schemas.

MOIS Information Flow

After receiving a list of titles, the user may input an MOIS number for any occupation and receive a short definition and a listing of the specific occupational specialties contained within its description. In addition, each selection is cross-referenced, when applicable, to specific MOIS file structures (Program, Apprenticeship, Military and School Subjects). Should other information pertinent to the user's choice be desired, one or all of the following options may be selected:

- 1) Nature of the Job
- 2) Working Conditions, Worker Requirements, Methods of Entry
- 3) Earnings and Advancement for the Occupation
- 4) Job Outlook for the Occupation
- 5) More Sources of Information for the Occupation

After exploring the occupational text, the user can request program and training information in the following areas:

- 1) Post-secondary training programs
- 2) Area skill center programs
- 3) Appropriate school subjects
- 4) Military training programs

The post-secondary program option allows for obtainment of a list of Michigan schools that have training programs related to each of the 200 MOIS occupations. Specific school coverage includes:

- 1) Community colleges
- 2) Public colleges and universities
- 3) Private colleges and universities
- 4) Private vocational schools

All information will relate to the occupation selected initially by the user. The computer selected the appropriate information from various internal files without the user's knowledge. To examine information about a different occupation, one simply returns to the section of the program that allows for input of an occupational number. Throughout the MOIS interactive program, users determine which information will be printed by responding to either "yes"/"no" or multiple-choice questions. This allows for direct entry into any file within the system. As a result of these options, the individual determines how much data will be printed. One may spend as little as two minutes or as much as twenty at a terminal. The amount depends on the depth of information desired by the user.

Implementation of the MOIS Interactive System

At present 22 data centers have expressed interest in adopting MOIS and providing it to their constituents. They represent large-scale systems, mini-computers, and even micro-computers. The initial version is written in Hewlett-Packard 2000F and Access BASIC. Its data files need approximately 2 million characters of storage. This BASIC version is compatible with the majority of potential MOIS distribution sites. It was designed to be as transportable as possible so that it may be installed with little or no modification. A COBOL version is now being examined for those users whose machines are not suited to BASIC.

Advantages of the MOIS Interactive System

As a result of both working with a variety of agencies and utilizing the expertise of those familiar with computerized guidance programs, MOIS has developed an innovative approach to occupational information. Some of the advantages of MOIS are:

- 1) Current national, state, and regional data
- 2) Simple, easy-to-follow instructions
- 3) Logical flow of questions
- 4) A structured search of occupations

- 5) Direct access to information
- 6) A program whose flow is under user control, not computer control
- 7) A computer program that is easily transported to a variety of computer systems
- 8) A package that is designed to operate on a wide variety of computer terminals, including teletype-compatible devices.

MOIS can be used as a stand-alone occupational information retrieval system or in conjunction with other career education and guidance activities. Its flexible nature makes it a valuable aid for anyone seeking occupational and educational information.

USING CAI WITH SOCIALLY AND
EMOTIONALLY MALADJUSTED STUDENTS

Paul E. McClendon

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This CAI project, funded by the Law Enforcement Assistance Administration, was a drill and practice program in mathematics and reading. The subjects were socially and emotionally maladjusted children and youth at the Children's Services Center in Tampa, Florida. The most important finding of the program was the positive attitudes expressed by the participants, since most of them were extremely negative toward any type of academic endeavor.

The CAI project which I shall discuss today involved drill and practice in mathematics and reading for socially and emotionally maladjusted students. The subjects were day students at the Children's Services Center in Hillsborough County, (Tampa) Florida, where they received psychological treatment as well as their regular schooling.

This project developed as so many others of its kind in that available funds dictated where, when, and with whom the program would operate. After moving to the University of South Florida from Delaware, where I directed an ESEA Title III project in educational technology, the only place I could locate funds for CAI was the Law Enforcement Assistance Administration. These funds were administered through the State Criminal Justice Department.

Our initial plans were for a regional project including correctional facilities in several counties in the Tampa Bay Area. However, shortly after the original proposal had been written, the state's criminal justice planning units were reconstructed so as to allow each county to plan its own program. This meant rewriting the proposal and restricting it to Hillsborough County. Furthermore, available information indicated that funding for a very small project would be the only possibility.

Subsequently, a grant proposal was prepared for utilizing the computer in various phases of the operation of the center mentioned previously which was, at the time, the Lake Magdalene Juvenile Home. Here an educational program was operated for youth who were awaiting

court action and for those in a number of group homes.

The project's original purposes were as follows:

1. to use CAI for academic and vocational training
2. to teach a computer language
3. to store pertinent data on youth who were processed through the juvenile facilities of Hillsborough County
4. to use the computer for on-the-job training of supervisory personnel in the juvenile detention facility.

The grant was funded on a 60% federal and 40% local ratio with the first year's amount being \$22,000. This initial year was given almost entirely to planning; however, one teletype terminal was installed to be used to teach BASIC to some of the mathematics students.* Since the terminal was available, I also wrote a drill and practice program for each of the basic operations on whole numbers which the students used successfully and very enthusiastically.

This minor computer activity was carried on simultaneously with the major thrust of the initial year; i.e., the needs assessment and other planning. The use of the Wide Range Achievement Test revealed that the mean achievement level for the school's population in reading and mathematics was more than two years

*The Hillsborough County Schools' computer, an IBM 370-335, was used throughout the project.

below the expected level. This was not unexpected, so plans were completed to concentrate on these two skills areas during the remainder of the project.

There was an extensive search for courseware, since there was neither time nor money to develop curriculum materials locally. The only available courses which seemed to suit our needs were the Arithmetic Proficiency Training Program (APTP) from IBM and the Elementary Reading Program from Computer Curriculum Corporation. APTP is a drill and practice course of thirty modules including the following: whole numbers, fractions, mixed numbers, decimals and percent. The CCC reading package covers the five skills of:

- Word Attack -- analyzing words as units
- Vocabulary -- building a reading vocabulary
- Literal Comprehension -- understanding the literal meaning of sentences and short paragraphs
- Interpretative Comprehension -- reading sentences for interpretation
- Work-Study Skills -- learning to use resources effectively

These two courseware packages were written in Coursewriter; and, since the only instructional use for the local schools' computer had been mathematics problem solving, BASIC was the only available language. The project's second year's funding -- a total of \$40,000 -- provided Coursewriter for the system, plus an additional port, which brought the total number of lines into the computer to four.* A second teletype terminal was also added at the school.

With four lines into the computer, our project had each terminal on-line for 2 1/2 hours per day. Each student with a mathematics and/or reading deficiency and who wished to participate was scheduled for two 10 minute CAI sessions per week. Monday through Thursday were scheduled times on the system with Friday being used for make-up. Incidentally, no student whom we considered in need of the program refused to participate.

Students were identified for the

*Since BASIC was still needed by the senior high schools, the problem of taking BASIC down and bringing Coursewriter up each day was solved by securing from Westchester BOCES a version of BASIC which ran under Coursewriter. This allowed both math problem solving and CAI to occur simultaneously.

program from results of the California Test of Basic Skills -- reading vocabulary and mathematics computation. With the range of skills in the APTP, every student at the school could use some part of the course; whereas only those pupils with vocabulary level between 2.5 and 6.0 could profit from the reading program.

With pre-test data on over fifty students, plans were to readminister the CTBS as a post-test at the end of the year. This proved to be impossible because of the excessive number of entries and withdrawals at the center. At year's end only eight students were still enrolled who took the pre-test in mathematics and only five who completed the reading pre-test.

Although the matter of pupil turnover was disappointing, the teachers and I felt that the year's operation had been successful. Our major reason for this optimism was that the students, almost all of whom had histories of school failure and dislike for formal education, seemed to like CAI. In addition, the few students on whom we had test scores made remarkable gains in both areas tested.

Our second year in the operational phase turned out to be drastically different from what was originally planned. First, funds were reduced by fifty per cent, and we were notified that the project would not be funded past this third year. This meant we could not attempt to meet objectives three and four of the original proposal, nor expand our offerings to any vocational areas. We were, however, able to operate with the same amount of computer time as previously, since the Hillsborough County School Board assumed the cost of Coursewriter and did not charge the project for computer time. The University of South Florida also assumed an additional 8% of my salary.

During the last year, we operated with only one terminal again; but, due to a change in scheduling, we were on-line between four and five hours each day. The teachers and I decided to use all the available time during this year for mathematics. This was primarily because the terminal was located in the mathematics classroom and too many problems arose with students from other classes coming into the room to use the terminal. This new schedule allowed the students in mathematics to receive a lesson from three to five times per week.

With this concentration on mathematics, a second attempt at testing was made. Since the facility had been changed from a place of detention to a treatment center, it was hoped that pupil turnover would be reduced. This was true to a

small degree since out of fifty students who took the pre-test, seventeen were available for post-test administration.

The period of time between testings was seven months. It can be seen from the following table that the mean gain in mathematics computation during this seven months was 1.9 years.

CALIFORNIA TEST OF BASIC SKILLS --
MATHEMATICS COMPUTATION

	Mean	Range
pre-test	4.4	1.7-8.6
post-test	6.3	3.6-9.1
gain	1.9	0.0-3.6

As was mentioned earlier, turnover in pupil population was a major factor in project evaluation. The facts presented show the impossibility of establishing experimental and control groups. Additionally, funding restrictions made it necessary to include all students at the center. The lack of experimental and control groups was not a major concern as the endeavor was undertaken, as there is ample research evidence in support of CAI as herein described; i.e., CAI used as a supplement to the teacher's instruction. "Studies have been fairly consistent in showing that increased achievement results from the use of CAI as a supplement to traditional instruction."¹

The most important outcome of this project, as seen by the teachers at the center and me, was the positive attitudes of the participants toward computer aided instruction. At the conclusion of the program, I personally interviewed each of the fifty participants at which time I asked the following questions:

1. How did you like the computer math?
2. Do you think it helped you learn?
3. Was 10 minutes per day an appropriate amount of time?
4. Would you like to use the computer for other courses?
5. What did you like most about the computer math?
6. What did you like least about the computer math?
7. What changes would you suggest?
8. If you had a choice would you (a) do all of your math at the computer terminal, (b) do all of your math with your teacher, or (c) do math with your teacher and the computer?

Attitudes expressed by the participants were very positive and enthusiastic concerning their participation in the drill and practice program. Of all the interviewees, only one indicated that he did not like the program; whereas all students indicated that they thought they learned from the experience. Ten minutes per session seemed to be best for most students, and 80% indicated that they would have liked other experiences at the computer terminal.

Responses to the open ended question concerning what they liked most about the activity were as expected concerning the desire for immediate feedback. An unexpected response which appeared with equal frequency was that they liked not having to write the problems before attempting the solution. The only negative comments dealt with telephone line problems and deterioration of response time; and there were no suggestions for change. Almost all students indicated a preference for a combination of the computer and their teacher as a mode of learning mathematics.

Summary and Conclusions

The major obstacle which had to be overcome to start a program of CAI where it had never been used before was the typical one of money. In our area the utilization of the computer instruction is far from being an accepted practice.

Once we were able to get the program off the ground and operational, all those involved were very enthusiastic and deemed it a success. The students, almost all of whom were extremely negative toward school in general and anything of an academic nature in particular, seemed to enjoy using the computer as an instructional aid, and we think it helped them learn. The one teacher who was involved for the longest period of time, and in whose classroom the terminal was located, became very skilled at coordinating teacher-directed activities with computer directed instruction. Contrary to what would be expected, the noise of the teletype was not a negative factor in the classroom.

Using CAI with socially and emotionally maladjusted students is very promising. People problems, of which these students have many, are eliminated in the interaction with the computer; and indications are they they learn.

1. Edwards, Judith, et. al., "Is CAI Effective," AEDS Journal, Summer, 1974, pp. 122-126.

WISCONSIN'S COMPUTER BASED CAREER INFORMATION SYSTEM

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The Wisconsin Occupational Information System (WOIS) is a computer based program relating to national and state occupations, educational institutions, financial aids and human resources. The system incorporates a manual backup system of printed and visual materials. The central staff of WOIS collects information from such "providers" as the Job Service, Department of Labor and educational agencies and organizes it for easy individual access by such "users" as high school students, the unemployed and other job seekers. During the first year the computerized system was designed and built. By October 1, 1976, WOIS began delivering information via six regional computing centers to 70 local high schools, technical schools and universities. The program is funded by a grant from the NOIS-DOL with matching funds from the WBVTAC and WMSC.

The Wisconsin Occupational Information System (WOIS) is a computer based program to provide quick, accurate and up-to-date occupational information for career decision making to a variety of publics. Student entrants into the labor force, the unemployed, minority groups, educational and manpower planners, inmates of correctional institutions and clients of vocational rehabilitation facilities are all potential users. The goals of the program are:

- 1) To help persons learn about and understand the range of careers now available and likely to be available in the future.
- 2) To help labor force entrants become aware of occupations which are acceptable and personally satisfying.
- 3) To encourage persons in the process of making career decisions to explore vocational possibilities on their own.
- 4) To increase awareness of major sources of occupational information.
- 5) To provide support for related programs including career education, career and employment counseling and manpower and educational training.

System components. WOIS contains three major components for delivery of information to users: computerized files, manual files and audio-visual materials. The

first major component consists of separate computerized files for 1) national occupations, 2) state occupations, 3) four-year colleges nationwide, 4) education and training of less than a baccalaureate degree, 5) financial aids and 6) human resources.

Access to the information files may be direct or structured and is accomplished via a computer terminal located at the school or other user sites. Structured access enables individuals to insert self descriptions which are then used by the computer to select occupations or other information depending upon the type of file. Direct access enables the individual to identify immediately specific information about jobs, colleges or other items from any file by directly inserting a code number which corresponds to the particular occupation, college, financial aid or training program.

The second major component is the manual delivery program, which provides printed copy or microfiche. Currently career beliefs and the Wisconsin Information for Students and Counselors (WISC) or VIEW are used to provide information. The WISC Deck and the computerized files are cross-referenced, as the WISC Deck contains expanded information on the various occupations and training programs. The primary difference between the computerized files and the WISC Deck are: 1) the WISC Deck uses longer descriptions of the occupations and training programs, 2) it is updated every two years, whereas the computer file is updated every six months and 3) it does not have a structured access program, only

direct access. Career briefs provide a general background on various occupations by industrial clusters, are updated approximately every four to five years, and contain approximately ten to forty occupations per brief.

The third component of the Wisconsin Occupational Information System consists of various types of audio-visual materials such as the Employability Skills Program and other career education filmstrips, films and audio tapes. These materials supplement the information in the automated, microfiche and printed materials files.

Involvement of students, parents, and professionals. The major components of WOIS are designed to be usable by the students. The computerized files, the WISC Deck, the Occupational Briefs, the Employability Skills Materials and other audio-visual or printed materials are all easily manipulated with relatively little instruction needed prior to operation. The students are provided with a user guide, worksheets and computer command displays developed for self-instruction.

When the student types in the appropriate command, this signals the computer to respond on the basis of instruction. If the student is just starting in the system, the computer will ask him/her to identify the program or file. The student then types in a code, such as NOCC for occupational information at the national level, or SOCC for information at the state level. He/she may also choose any of the other files in the system; steps for accessing the files are contained in the user guide. Disposable worksheets are provided so that the student guide may be reused many times. Five basic commands are used to interact with file information. The "A" command means add, "S" means subtract, "E" means either/or, "D" means delete and "P" means print. In addition to the specific letter command, the student inserts the number of characteristics to be included in the search strategy.

Each file operates in the same manner. The student selects from descriptor groups, adds, subtracts or deletes items as he/she progresses through the exploration of the file content. At various points he/she may ask the computer to print out certain kinds of information such as a list of schools, occupations, human resources or financial aids. He/she may also ask the computer to print specific information on any one or several of the titles previously listed. For example, the search may have been narrowed to three specific occupations. First the titles of the occupations can be printed and then the complete descriptions of one or all three. The printouts provide a permanent record for the student and may be used for discussions with counselors, peers

or parents. When sufficient information has been secured, an appropriate command is entered which signals off the file and readies the system for selection of another file or the exit program.

The exiting strategy, currently under development, questions the student about whether the necessary information was provided. For example, if satisfactory information is secured, the computer responds with the next step in career planning. This may be a visit to a counselor or consideration of another resource such as Employability Skills or other printed materials. If the student does not secure the information, the computer will respond with directions to re-enter the system or obtain additional information from other sources such as the WISC Deck or printed information. The specific directions will depend on the student's assessment of the interactions with the system.

The WOIS instruction manual details the file information and the strategies used in accessing the computerized files. The interrelationships of the computerized files, the manual WISC Deck, the Occupational Briefs and the audio-visual materials are also explained. The manual provides information on access to or utilization of the file which is not included in the student user guide.

A guide for parents is also included. This explains the system, the kinds of information available through it and the process used to obtain the information. It contains suggestions on how parents might discuss this information with their child, an explanation of the computer printout and a listing of other information which may be available to the student.

File contents. The occupational information files are the most significant part of the system. Detailed descriptions of over 400 occupations at the state level and over 1700 occupations at the national level are included. The WOIS staff are working closely with the Bureau of Research and Statistics, the Department of Industry, Labor and Human Relations, the Job Service offices throughout the state and other information sources to supply accurate information. Each occupation is assigned a six-digit code number from the Dictionary of Occupational Titles. This serves as a source for exploring other occupations with related work characteristics. In addition, the occupations are cross-referenced to the other files, to the WISC Deck, to educational requirements and to military occupations.

The purpose of each job is defined and explained in terms of specific duties and tasks. The working conditions or work environment are also detailed. Information

is included on where the work is done, e.g., inside, outside, assembly line or small office. Work hours, limitations, temperature and climate conditions, the degree of physical involvement (including any special or dexterity problems), the amount of personal contact with others and environmental problems are incorporated. Information on earnings, including hourly rates and beginning, average and maximum salaries appear in the description. Pay provisions, fringe benefits, vacation and other economic considerations including costs to the worker for union membership, tools, uniforms and equipment are found in this material. There is a complete description of job supply and demand with employment forecasts on state and regional bases.

Each job description has a formal career ladder and explains promotional opportunities and pre-entry requirements including training levels and locations. Jobs with similar work traits are referenced, as are several sources of additional occupational information within WOIS. Military occupations are cross-indexed to enable the user to relate civilian job titles to those used in the military. References direct the user to the military occupations source books for further information.

The education and training files contain information on four-year colleges nationwide and more than one hundred Wisconsin institutions which provide less than a baccalaureate degree. The Wisconsin file covers all of the public vocational-technical schools, the two-year University centers, proprietary schools and others. Information on programs of study, fees, tuition, size, location, extra-curricular activities and many other points of information are covered.

The financial aids file contains information on federal, state and local student financial aids. It describes the type of aid, eligibility requirements, application procedures, source of further information and other pertinent details.

The human resource file is designed to provide the user with names and addresses of individuals, agencies and organizations which may be contacted for further information concerning occupations, careers, career planning or other student needs.

The software for the delivery system. The software for the delivery of the computerized information is the Guidance Information System II (GIS II), a product of Time Share Corporation and the Houghton-Mifflin Company. The present Guidance Information System evolved from concepts and experiences resulting from a project sponsored by the U.S. Office of Education at Harvard University. This project, the Information System for Vocational Decisions, was a

three-year effort initiated in June, 1966, by Dr. David V. Tiedeman, Professor of Education at Harvard.

The Guidance Information System makes it possible for students to explore large data files stored in a computer and to examine the ways in which their personal criteria for selecting occupations, education and the other information affects the range of opportunities available to them. When the student sends instructions to the computer, he/she receives an immediate response which allows him/her to compare the results of choices and decisions with the results of other choices.

The unique feature of the Guidance Information System is that it allows for direct interaction with the information. The user can change instructions at any point, thereby taking responsibility for decision making. The intention is not to provide matching or placement services, but to close the communications gap between the facts and those who need to use those facts for effective career choices.

The design of the software system is such that each file is entered individually. This characteristic has both advantages and disadvantages. The disadvantage is that a student must select one file to work with at a time and therefore cannot secure information from another without changing files. Among advantages of this type of system are that core requirements are small, making it inexpensive to run and that the addition of files to the system, such as a human resource file and financial aids file or others, does not overload a small computer.

Hardware for the delivery system. Hardware used in the delivery of the WOIS includes computers, telephones, computer terminals, microfiche readers and/or reader/printers, filmstrips, slide and movie viewers and cassette players. Several types of computers are currently in use, including the Hewlett-Packard 2000 and 3000 series, the UNIVAC 1110 and the DEC PDP 11/45. In the near future it is expected that the program will run on IBM and Burroughs equipment as well as other models of the previously named systems.

Teletypes connecting the computer system vary in cost and design. The most common are basic teletype units capable of printing ten characters per second, although units capable of up to 30 characters per second are rapidly replacing the slower machines. The slower units use mechanical printing capability while the faster ones generally have thermal printing features. Cathode-ray tube (CRT) terminals with thermal printers are also possible. The printing capacity is necessary to provide users with a permanent record of the information requested. The terminals are

connected to the computer by either dedicated telephone lines or a dial access system. The dial access utilizes a regular telephone with an acoustic coupler at the terminal. When the telephone receiver is placed on the acoustic coupler, it connects with the computer. The dedicated line is a direct connection from the terminal to the computer and is generally the most economical. Microfiche readers and other audio-visual tools found in most audio-visual departments are also used with the program.

WOIS user costs. The cost of providing WOIS to the user is between two and four thousand dollars per year, per terminal location. This cost includes the computer time, terminals, line charges, inservice training, the WISC Deck, the student user guides, instructional manuals and the student worksheets. Additional cost on a one-time basis may be incurred to acquire audio-visual and other printed materials. The cost to an individual school depends on three things: 1) the type of terminal rented or purchased, 2) the distance and type of communication line to the computer source and 3) the number of students having access to the individual terminal. Every attempt has been made to keep the cost to a minimum. Considering the quantity of information and its comprehensive and current nature, the cost for full time use of WOIS is surprisingly low. Approximately 1,000 students can be accommodated on one terminal during an academic school year. In many schools, the cost of the hardware and communications can be spread over additional uses, such as computer assisted instruction and administrative systems available at the distribution centers.

Organization of WOIS. The Wisconsin Occupational Information System is governed by a Board of Directors, a policy-making consortium representing secondary and higher education, manpower and social service agencies, management, labor and other interested groups. The Board constitutes a Special Task Force of the Wisconsin Manpower Council. It meets bi-monthly and is actively involved in the development and implementation of the system.

A central staff takes responsibility for overall system development and updates occupational information for the delivery centers. It collects information from "providers" such as the Job Service, Department of Labor, educational agencies, state planning agencies and business and industry and organizes it so that "users" will have easy and consistent access to it through various media of delivery. These media include written materials, audio-visuals, computer terminals and microfiche.

State-wide delivery of WOIS is organized through regional distribution centers,

existing or planned facilities capable of delivering computer assisted instruction to local high schools, colleges and other agencies. Regional delivery makes use of existing computer center and terminal configurations, minimizes telecommunications costs and allows the system to run on different types of hardware. A central computing facility provides regional centers with an updated tape twice each year.

Development of WOIS. Currently in its second year of operation, the program is a result of a grant from the U.S. Department of Labor/National Occupational Information Service. Seven additional states from an initial 45 applicants were also funded. The Wisconsin Vocational Studies Center, University of Wisconsin-Madison, was chosen to implement the program with the Wisconsin Manpower Services Council acting as the state agency responsible for receipt of funds. The grant is expected to continue after the second year, until the total operational cost is borne by the agencies and users involved. Currently the Wisconsin Board of Vocational, Technical and Adult Education and the Wisconsin Manpower Services Council are providing matching funds.

The need for a state-wide occupational information system in Wisconsin was made clear when several agencies within the state made independent attempts to provide information to those in search of jobs or job training. None of these programs was of sufficient scope to be classed as a statewide comprehensive occupational information system. The necessary stimulus for the statewide network was the WOIS grant program.

Summary. The Wisconsin Occupational Information System provides young persons and adults in Wisconsin with a unique and comprehensive source of information for career planning and decision making. Using the automation of computers coordinated with manual information files, the system relieves professional staff of the time-consuming chores of gathering, filing and relocating information for student or client use.

Major components of the automated system include information at the local, state and national level pertaining to occupations, vocational training, four-year colleges, military jobs, financial aids and human resources for personalized occupational information.

The effort of a consortium of state agencies to provide this comprehensive system of career information and related guidance materials enables local schools, colleges, technical institutes, Job Service offices, vocational rehabilitation offices and others to benefit from the system at a fraction of the cost of individual development and maintenance.

INSTRUCTIONAL SUPPORT & CURRICULUM

Post Secondary & Higher Education

A MODEL FOR APPLYING COMPUTER SIMULATIONS TO INSTRUCTION

by

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This paper presents a model which should be considered by anyone wishing to evaluate an existing computer simulation for use in reaching course curriculum objectives. The model contains several steps which should be taken when planning a student activity around a computer simulation. Furthermore, the model contains elements for assessing the effectiveness of the activity and making refinements for future use.

The Computer as an Instructional Medium

There are many instructional applications of the computer in education. These applications can be classified into two categories. The first is the use of the computer as a medium for instruction in various curricula such as science, mathematics and social studies. The second is the study of the computer as a curriculum itself. That is to say that there are existing courses in schools with titles of Computer Programming, Computer Science, Computer awareness, Computer Occupations, Introduction to Data Processing, and so on.

Applications of the computer as an instructional medium can be further sorted into two categories, simulation and modeling.

Computer simulation can be executed by persons with no knowledge of computer programming. The only need is an understanding of how to access the program and input the data necessary for execution. Simulations are typically used when there are reasons for which students cannot study the conditions being simulated. Some of these factors which prohibit the study of real conditions are time, cost, safety, and geography.

Modeling can be thought of as the creation of a computer program which models a real situation. This would include the construction of a program to model a concept in mathematics, science or data handling. Many scientific programming applications fall into this category. The author of a simulation would be modeling a real world condition when writing the program.

This paper discusses the use of computer simulations as instructional resources when the real environment is not present in the classroom or laboratory. In instances of this type, computer programs may be available to simulate the experience for students.

Simulation Versus Curriculum Objectives

One must understand when selecting a simulation to attain certain curricular objectives that the objectives of the simulation may be different. For example, a simulation in population growth may be written to assist a learner attain certain environmental objectives. However, the simulation may be used as a media to assist student attainment of specific objectives in statistics.

For example, the objectives of the author of USPOP a Huntington II simulation program could be stated as follows:

The student will:

- State the effect of fertility on population growth.
- State the effect of time of birth of first child on the population growth rate.
- State the effect of reducing infant mortality on the population growth rate.
- Discuss the factors affecting age distribution in a population.

In a statistics class, a classroom teacher might select this same simulation as a media to be used by students in the classroom. The objectives for students in this class might be:

- The student will construct and interpret histograms.
- The student will construct and interpret frequency polygons.

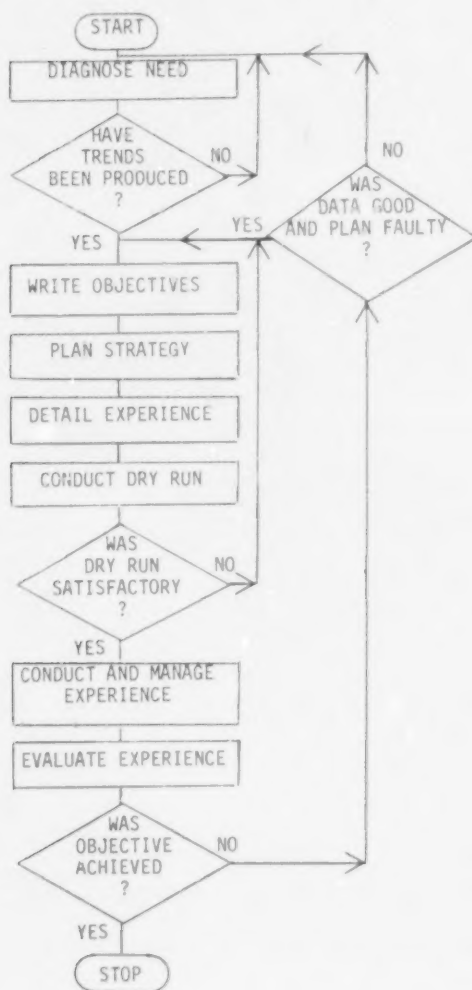
The differing instructional objectives do not prevent the use of the simulation in mathematics education. In fact, the environmental objectives may promote class discussion and learning which is secondary, yet relevant to the curriculum objectives in statistics.

Laboratory Learning Experience

A laboratory learning experience is an experience planned for students. It is based upon specifically stated curriculum objectives. The

experience is defined to organize the learners in small groups of temporary duration. It utilizes data and ideas generated within the group to form conclusions about the experience. The group conclusions are altered by analysis of feedback brought about by its conclusions. That is, generally, group conclusions are considered correct until feedback about the conclusions causes the group to refine their thinking.

As a teacher planning a laboratory learning experience there are several stages of development which need to be considered. These are diagnosing the situation, writing objectives and planning the strategy, detailing the experience, conducting a dry run, conducting and managing the experience, and evaluating and refining the experience. The following flow chart illustrates the relationship between these stages. The paragraphs which follow the flow chart describe these stages in more detail.



In order to diagnose the situation properly the teacher must consider several elements. The understanding, attitudes, skills, and responsibilities of the students must be considered. Furthermore, the same understanding, attitudes, skills, and responsibilities of contributing staff members must also be assessed. Then the simulation being considered must be executed until favorable trends in the data are produced. These trends must be analyzed to determine if they support learning of specific curricular objectives.

When a simulation is found to support instruction, the objectives of the laboratory learning experience can be written and the strategy of the experience planned. When planning the strategy, skills of group planning should be utilized. That is, a group of people should meet to share previous experiences with the simulation and instruction. Alternative strategies should be generated through brainstorming. Once a strategy seems to be satisfactory it should be evaluated by asking the following questions. Does the activity fit the objectives? Does it promote group activity? Does the activity promote inquiry? Is the time necessary for the activity realistic? If a strategy seems to meet these criteria then that alternative should be selected.

The experience can be detailed. The strategy should be described in writing. This includes how the activity is to be introduced to the learners, what tasks they will be performing and how the activity and the learners will be evaluated. A time schedule should be developed. Consideration must also be given to the materials and equipment necessary for the activity to be successfully accomplished.

Once this is done, the dry run may be conducted. The staff should put themselves in the learner's role. The tasks are to be done as directed to assure the staff that they are specific and communicate what is desired. This is the time that the materials can be evaluated and the necessary equipment checked out. The dry run is also an appropriate time to look for opportunities to change the direction of the participants in the event that such changes would be necessary when conducting the actual experience. The importance of the dry run should not be deemphasized. If the learner's role is actually assumed, problems with the details of the activity can be quickly identified and corrected.

The staff work necessary to conduct and manage the laboratory learning activity is reduced through the planning outlined above. Staff members need to specifically state what the learners are to do and what may be expected from them. The activity of the participants must be carefully observed. Mid-experience changes must be made if the direction groups are taking require such changes. Finally, the evaluation of the experience should be made through participant reflection on the activity. Feedback should be recorded for consideration when refining the laboratory learning experience.

Following the student participation in the experience it should be evaluated by staff and refined if necessary. Reflect on what happened. Evaluate the degree to which the objectives were met. Evaluate the behavior of staff members and participants and its effect on the laboratory learning experience. Finally, determine changes in the experience that should be made in order to improve its future use.

CERTIFICATION OF HIGH SCHOOL TEACHERS OF COMPUTER SCIENCE

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Computers are touching the lives of practically everyone in a very direct way. However, most of these people do not understand how the computer works or how it affects their lives. In order to reach the greatest number of people before their entrance to our computerized work world, the secondary schools will have to present a well organized program of study in computer technology. Because of this, computers are becoming more and more prevalent in secondary schools. This constitutes a need for qualified teachers in the area. Thus, it is necessary to define the organized program of study and the level of preparation or qualification of teachers performing various tasks in this field.

In our ever changing society where computers are fast becoming the rule and not the exception, people from all occupations will need to acquire some knowledge of their use. The computer is now being used in almost every business area: banking, insurance, retailing, architecture, and medicine just to name a few. Besides being in contact with computers while we work, we must also deal with computerized cash registers, televisions, cars, clocks, ovens, stereos, and whatever computer technicians might come up with next.

The President's report on Computers in Higher Education states that we are giving a second class education to the majority, because adequate computing facilities are not available in all colleges. But even if this problem were overcome, the majority of the people in this country never attend college. The place where computer education can make the greatest impact on our society is in the secondary schools. For this reason, the teaching of computer-related courses is becoming more and more common in the secondary schools. Therefore, we must have teachers who are qualified in the area of computer science to teach these courses. This may not seem to be too important a problem because of the lack of computer availability in the public schools.

Computers are available to students now in large cities and are moving into smaller districts at a fairly rapid rate. The Texas Education Agency has stated they will make available to every school within a sixty mile radius of one of the twenty Regional Service Centers either a remote job entry terminal, an interactive terminal, or a computer mainframe. They

now have portable terminals that are taken to remote school districts in most Service Center regions once a month.

Computer science instruction at the secondary school level may be divided into three different areas: (1) problem solving, (2) general education, and (3) job preparation.

Problem solving is the use of computers to help solve problems encountered in other academic areas. The subject which has in recent years been most affected by the computer as a problem solving tool is mathematics, although its use is becoming more frequent now in chemistry and physics. Many teachers in these academic areas have had little or no experience whatsoever with the computer.

Computers as a part of the general education of all students are essential. Computers are already too much a part of our everyday life for us not to have some general understanding of how they work and how they can affect us. Computer literacy courses are being offered to help the students understand what computers can and cannot do. These computer literacy courses do not necessarily require any computer equipment. However, any equipment that the students could see, and more especially that they could use, would be of great benefit in learning the general concepts of computing.

The third instructional area of computer science is for job preparation. The number of jobs at all levels of our ever growing industry, is increasing at a very rapid rate. The job market has not yet begun to be saturated. Therefore, we need computer courses in the secondary schools to prepare high school graduates for entry level jobs or to give them the basic knowledge needed for computer-related courses

at vocational schools, community colleges or senior colleges.

Teachers of other academic areas are expected to use the computer in their instruction, especially teachers of the sciences. All secondary school teachers need to have an introductory course in computer science for two reasons: (1) so they will not fear the computer and will try to use it in their own discipline and (2) so they can show their students how the computer is related to real life problems in their own area.

For the other two areas of computer science, general education and job preparation, certified teachers of computer science are needed. In 1973 Texas became one of the few states which offers a teacher's certificate in Computer Science, after a long hard fight by pioneers of computer science education. East Texas State University is one of the few universities in Texas which can request this certification for its graduates. We feel that this is a very commendable program and that all teachers of computer related courses in the high schools should be certified, but our graduates are not going to work for the public schools. The biggest reason, of course, is that the public schools cannot pay as well as industry. Another important reason is that schools do not require their teachers to be certified or even to be working toward certification. This policy needs to be corrected.

A suggested curriculum for the eight courses required in Texas for a secondary school certificate and a short description of these courses are as follows:

Introduction to Computer Science: A study of the cultural impact, history of computers, and fundamentals of information processing machines; algorithms, flowcharts, and an introduction to a procedure oriented language with general applications. The languages most often used are BASIC and FORTRAN (FORMula TRANslation).

This course would also be the one mentioned for secondary school teachers from all areas.

COBOL Programming: A study of ANSI standard COBOL (Common Business Oriented Language) and commercial applications of the language.

FORTRAN Programming: A study of standard FORTRAN with an emphasis on physical science and mathematical applications.

Introduction to Assembly Language Programming: A study of the symbolic instruction set of a modern digital computer. Machine representation of data and instructions, logical input/output control system, addressing concepts, binary integer arithmetic, and packed decimal arithmetic.

This introductory assembly language course can be taught on any computer but I feel that it is best, if possible, to teach IBM System 360-370 Assembly Language because it is the most widely used.

Advanced COBOL Programming: Management of large volumes of data in business situations: record keeping, payroll, and inventory. Extensive use of disk, tape, and card files and input/output involving these files. Quality control and simulation techniques.

Computer Organization: A study of the hardware and software characteristics of modern digital computers. Hardware topics include data representation, machine instruction types, interrupt systems, and micro programming. Software topics include multiprogramming, time-sharing, subroutines, input/output control systems, and searching and sorting techniques.

Systems Analysis: A study of the systems approach, problem identification and definition in information processing, system studies and surveys, the feasibility study. Data collection and evaluation. Process identification and design. Communication with system designers and implementors. Simulation techniques for systems analysis.

Teaching Methods in Computer Science: Theoretical and practical study of teaching methods utilized in the teaching of computer science in secondary schools. This course also involves teaching twenty minute segments to some computer science class.

Some courses which would be helpful if taken for electives are as follows:

Keypunch and Data Entry: An instructional program designed to train operators of data recording equipment including card oriented keypunch machines and various other devices of a similar nature such as data recorders which utilize magnetic storage and direct data entry devices.

Computers and Society: A study of the influence of computers on society, human factors related to information processing systems, social issues regarding automation and privacy and the control mechanisms of men and machines.

Computer-Assisted Instruction: A study of the systems approach to the development of instructional packages for CAI. Implementation of drill, tutorial, and simulation programs using the Coursewriter author language.

There are also some things being done in the in-service training area. East Texas State University offers a mini-term (two weeks) course which is sponsored by the Texas Education Agency and offered in different parts of Texas each year. The course is designed to meet professional development needs of Junior and Community College data processing or computer science teachers in Texas. The instructors of this mini-term course discuss the latest developments in the area of data processing. This course and others have been sponsored by the Texas Education Agency for Junior or Community College instructors but they would be just as beneficial for secondary school data processing or computer science teachers. Secondary school teachers have not been included because they really do not exist as a group and they will not exist as a group until the states require certification. These mini-term courses could also be used as courses needed for certification since they are actual graduate courses taken for college credit.

Since the sixties authorities in both computer science and education have been telling us that if the high schools do not start teaching their students about how the computer is affecting their lives then they are not giving them a proper education. Many states have realized this and are moving toward having computer courses in, at least, their largest schools. The question that now arises is "Are the teachers qualified to teach these computer science courses recently added to high school curriculums?" The answer in many cases is, of course, yes even without certification but with certification the affirmative answer would more often be the case. Why should computer science be the only discipline where certification is not required? Our state education agencies need to take a closer look at the qualifications of teachers in this ever changing field.

References:

Computers in Higher Education - Report of the President's Science Advisory Committee. February 1967, U.S. Government Printing Office.

Majernik, John A., Business Education Forum, "EDP - A Must in the Secondary Schools", Vol. 28, No. 6, March 1974, pp. 35-36.

Ray, John R., AEDS Monitor, "EDP Training for Teachers - an unmet need", Vol. 13, No. 6, Oct. 1974, p. 8.

COMPUTER-AIDED DIAGNOSIS AND PRESCRIPTION
OF INSTRUCTIONAL EFFECTIVENESS

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Programs and procedures have been developed that assist university student teacher supervisors in the quantitative evaluation of student teacher instructional effectiveness. Features of the programs include a graphic diagnostic profile of variable means, summary diagnostic statistics, user variable criterion scoring and prescriptive suggestions for improved instructional effectiveness. Features of the process include a systematic method for the compilation, analysis and feed back of data related to the perceived instructional effectiveness of student teachers. Potential applications of this process in related fields is discussed. Examples of output will be available.

Accurate and efficient assessment of instructional effectiveness is one major goal of educational administrators, supervisors and classroom teachers. Traditional problems surrounding the evaluation of instruction include the lack of suitable criteria, the lack of rater objectivity, the lack of immediate feedback, a lack of diagnostic accuracy and an absence of prescriptive capability. While some instructional evaluation programs address these specific problem areas more effectively than others, few if any, make use of institutional computer-computational, storage and prescriptive capabilities.

The Classroom Teacher Inventory (CTI) was developed by Brooks (1977) as a measure of pupil perceptions of perceived instructional effectiveness. The CTI is comprised of two subscales, the Teacher Characteristics Survey (TCS) and the Teacher Behavior Survey (TBS). The TBS is a nine item survey which solicits pupil responses on a Likert-type scale to questions which reflect nine instructional variables shown to relate to pupil achievement and attitude gains. The TBS may also be used by supervisory personnel as a measure of instructional effectiveness. Students respond to the TBS on an IBM form answer sheet, D.S. 1120-C, using response numbers 1 - 9.

Once the response forms have been completed, they are scanned by class and analyzed using a program developed by Hilek (1977). The program diagnostics include a mean score for each variable within a class, a visual profile which plots the means by variable name and a

prescriptive statement if the mean score is above the criterion level judged as reflective of instructional effectiveness.

Hypothetically, if a criterion level of two (2) were selected on the variable labeled "perceived clarity" and the mean score for that variable exceeded (2), then a prescriptive statement would be produced. This material would recommend to the supervisor, teacher or evaluator a prescriptive strategy for improving the mean score of the teacher. Logically, a teacher's profile could be stored for comparative purposes. Additional, situation specific, prescriptive statements could be included.

The applications of this diagnostic process seem limitless, given the computer-aided nature of the procedure. Supervisors could implement a management by objectives model. Teachers could readily monitor their own instructional effectiveness. Program prescriptions could be tailored to address district remedial resources and facilities.

In summary, computer-aided evaluation of instructional effectiveness may respond to the more serious questions surrounding faculty evaluation. Objectivity is enhanced; computational error is eliminated; criterion- as well as normative comparisons, are available; efficient data storage and retrieval is available; and most importantly, the opportunity for immediate assessment, diagnosis and prescription is realized.

COOPERATION IN COMPUTER SCIENCE EDUCATION
BUILDING A COMMUNITY OF ADULTS

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A model of education based on cooperation among responsible individuals is presented. Earlier models are discussed which involve traditional competitive-based courses as well as the more recent individualized mode. The latter has been used by the author for several years, utilizing both a personalized system of instruction (PSI) and computer-based education (CBE). Now, however, cooperation has been introduced as an explicit and integral part of education. The techniques utilized in an introductory computer science course include: study partners for PSI units, computerized personal data base design by a small group, mutual design and use of interactive programs, use of cooperative exercises (computer and otherwise) and parties.

Introduction

In this paper, the concepts of community and the individual are compared and contrasted. The realization of these concepts has been implemented in the classroom by maintaining a delicate balance between cooperative efforts and individualized instruction. Preserving this balance is advocated as a preferable alternative to either the traditional lecture mode or, more recently, the primarily individualized mode of instruction. Considerable experience has been gained with the individualized mode, utilizing both personalized systems of instruction (PSI) and computer-based education (CBE) over a period of several years. The explicit introduction of cooperation into the computer science classroom is of more recent vintage. It comes in response to a belief that cooperative efforts are most likely to solve the difficult problems of today, and to fears of interpersonal isolation which may result from exclusive or primary reliance on individualization.

Definitions (11)

Community: a social group or class having common interests

Common: belonging equally to two or more; shared by all alike; joint

Cooperate: work together toward a common end or purpose

Cooperation: an association of

persons for mutual benefit

Individual: of or relating to a single human being; by or for one person

Individualize: to modify or suit a particular entity

Why is a Community of Individuals Desirable?

Whenever I meet a class for the first time, one of the first questions I ask them is: "Why?" "Why are you in this course?" "Why are computers becoming such an integral part of our lives?" Why is understanding their uses and potential so important?" To me, asking "Why" is an essential first step in looking at a new idea. No particular solution is guaranteed to result. Rather, oftentimes, an increased awe and reverence for the phenomenon results. Nevertheless, when the phrase "community of individuals" first began to have some significance for me as an instructor, I needed to ask, and perhaps answer, the "Why" question.

I believe that a community of individuals, working together in cooperation toward mutual goals represents the most hopeful and realistic structure whereby the majority of the important problems confronting us today can be solved. The difficulties and enigmas which surround us today are legion and increasingly severe. For cogent and striking presentations of the present and possible

futures, recent issues in the Portable Stanford Series are outstanding (4, 12, 13). Of particular import is Harman's An Incomplete Guide to the Future. Wars, unemployment, famine, inflation, civil rights, crime, welfare, corruption -- the list appears endless.

Few of these, if any, are solvable by one person. What are the alternatives: to continue to accept such problems as "natural" or treat them as "inconveniences"? I, at least am not willing so to do. Rather, it is my firm belief that a dedicated community of strong individuals offers a viable and desirable alternative.

Alternative Models in Education

The belief in a dedicated community of strong individuals is manifested within the framework of introductory computer sciences courses at Indiana University-Purdue University at Fort Wayne. I strongly believe in the impact that models have on our later lives. Hence, I try to include in classroom situations those values which have positive significance for me, i.e., community of and cooperation among mature persons. It is this model I wish students to consider seriously now and in later life.

Students will definitely have other models from which to choose. One of the most common and powerful ones is based on competition, and is usually found in a traditional lecture-oriented course. In earlier papers, my thoughts were shared about where and when competition may be appropriate, e.g., sports, and where it is not appropriate, e.g., education (7, 8). In a recent address, Howard Casney, Minnesota commissioner of education, noted that education today is "Predicated on failure" (1). However, a grade of A or B in a course must indicate that a student has demonstrated mastery of the subject. It must not indicate that she/he is in the top 10% who demonstrate mastery in a predefined, usually short, time frame, e.g., an hour exam, a two hour final, a one semester course, or a four year degree, etc.

So we are led naturally to another, and rapidly growing, model in education: that of individualization. Casney espouses the use of computer-based education. Personalized systems of instruction are also vitally concerned with individualized instruction. This model is leading to persons increasingly able to become adults, i.e., persons who assume responsibility for their own actions. It is a model I view with great respect and admiration. I have used it for the last four years in several courses.

However, I've come to realize that strong individuals, by themselves, do not constitute a complete picture. You and I really do live in a community, several of them in fact. I do not wish to live a life apart from others. I wish to participate, as a strong person, in mutual efforts with the other strong people to solve significant problems and to share with them at increasingly open and intense levels. The latter quality is not a "teachable" one in my opinion, but rather flows naturally from significant mutual content-based concerns. Therefore it is this model of a dedicated community of responsible individuals that I value highly, and consequently emphasize in many of my courses.

Cooperative Course Efforts

The course in which major efforts have been expanded to incorporate cooperation is CS 220, Introduction to Algorithmic Processes. Section enrollment is usually between 20 and 25, and consists primarily of science majors ranging in age from 18 to 30. It represents the first direct exposure to computers for all except those with some experience in high school.

The primary cooperative efforts in CS 220 include the following: study partners for PSI units, data base design by small groups, mutual design and use of interactive programs, use of cooperative exercises, and parties.

1. Study partners for PSI units

As most of you know, a personalized system of instruction, also known as the Keller plan, has become one of the most noteworthy and exciting instructional methods in recent years. Earlier referenced papers of mine discuss it at some length, as well as in (9, 10).

An integral part of PSI is breaking material down into digestible pieces or units. For CS 220, there are 15 such units (two of them review ones), plus a final. Within the cooperative PSI framework, each student is assigned a partner on the first day of the course. The partner is usually of the opposite sex, roughly the same year in school, but not necessarily in a related discipline. During the next couple of class days, the partners introduce each other to the class informally.

The PSI partners are encouraged to work together on the objectives and suggested procedure of each unit. The evaluation, of course, is administered separately. Since most of the units involve designing and implementing computer programs, a variant of "egoless" programming is suggested (2).

2. Automated personal data base design by small groups

After nearly one-half of the semester has passed, most students have a working knowledge of the primary programming language concepts. It then becomes feasible to introduce them to a design project. Since such projects outside the academic world are usually cooperative in nature, this is a good opportunity for small groups of 3-4 to work together. I wanted the design to be for a realistic area and one of some importance. Automated (computerized) personal data banks immediately come to mind. A group in the College of Education at the University of Illinois under the direction of Bruce Hicks has also investigated such issues (6). In CS 220, however, the students are not only users of such data banks, they will also be designers thereof. The complete assignment is available upon request.

3. Mutual design and use of interactive programs

After some introductory simple programs which all students are to complete, students are given a choice. They may either work on problems assigned in the unit, or they may choose one of their own, so long as it is of comparable complexity. Several people have opted for the latter. Here they can use the computer directly for a problem in their discipline, or they can design and implement a game, simulation, drill and practice, etc.

In any case, whether the students work on a preassigned problem or one of their own, they are encouraged to seek out an "intelligent but naive" classmate to be a typical user. This user, who is often their partner, takes the program. She/he writes comments relating to directions, accuracy, style, etc., and then signs and dates the listing. She/he is not expected to examine the coding itself. If necessary, the author then modifies the program before turning it and the signed listing in as part of the unit test.

4. Use of cooperative exercises, computer and otherwise

Until relatively recently, this topic would have been virtually nil. However, there appears to be an increasing awareness that a model of cooperation is at least as important for education as that of competition. Star Trek, Moonwar, Battleship, etc., all have a certain fascination, but how about cooperative games, also? In a recent issue of Computers and Society, Bruce Hicks discussed several such games (5). "SOS" is available on PLATO and "Lost and Forgotten Island" is available in Basic. In these games, cooperation is espoused for

the mutual benefit of all players. After playing these, students (and instructors) now have some models for community-building lessons. There have also been several programs in issues of Creative Computing (a great magazine!) which promote cooperation rather than shooting down Klingons (3).

I do not restrict cooperation to be viable only when interacting with the computer. This is, however, an increasingly important type of CBE lesson, in my opinion. Students also share together in discussion about films. Controversial ones such as The Right of Privacy or A Matter of Survival (both available from Indiana University) prompt conversations in which significant and honest feelings are exchanged. People learn to relate to others who may have strong, but different, thoughts. Many of the exercises in Values Clarification by Simon, Howe, and Kirschenbaum are useful in this domain also (14).

It would appear that more and more people are realizing that cooperation is an increasingly vital element in our lives. That is why I am concerned that students have first-hand experience with this model.

5. Parties

One of the essential ingredients of community is knowing one another. Parties provide an excellent first step for learning one another on an informal, and non-threatening basis. And, because they are so much fun, we try to have several!

The "content excuse" for most parties is the celebration of a student's birthday. Donuts and cider usually provide a common basis for sharing physical sustenance while the class continues. Frequently the student may indicate their special plans for the day.

Summary and Future

In summary, I have tried to indicate why I believe cooperation to be a valuable and integral part of education. It is compared to a traditional mode, usually based on competition, and then to the more recent mode of individualized instruction. The latter has often been implemented, in my courses and others, within a PSI environment and frequently involves computer-based education. These individualized techniques have done much to eliminate the idea that only 10% of students are able to master the material presented. However, most serious problems in the world are solved by a community of responsible people.

It is in this belief that cooperation is introduced explicitly in my introductory computer science courses. The primary cooperative efforts are:

1. study partners for PSI units,
2. design of a computerized personal data base by a small group,
3. mutual design and use of interactive programs,
4. use of cooperative exercises, computers and otherwise, and
5. parties.

What of the future? Only the future itself knows. But I would hope that my understanding of people and the learning process would grow and mature. It may well be that cooperative efforts are "not all they're cracked up to be." The values of one's own self and of one's God are probably pre-eminent. Yet, at the same time, we live, love, work, and learn in a community of others. I am grateful for that opportunity, enjoy helping others, and enjoy being helped by a caring community of responsible individuals.

BIBLIOGRAPHY

1. Casmey, Howard B. "Computer-Based Education: An Approach Toward Adaptive Learning Procedures." ADCIS Summer Conference, 1976, pp. 1-22.
2. Cheney, Paul. "Egoless Programming: As an Instructional Technique." AEDS 14th Annual Convention, 1976, pp. 222-224.
3. Creative Computing, David Ahl (editor), Morristown, New Jersey.
4. Harman, Willis W. An Incomplete Guide to the Future, Stanford Alumni Association, Stanford, California, 1976.
5. Hicks, Bruce. "Computer Outreach." Computers and Society, ACM Special Interest Group, Volume 7, Number 3, Fall, 1976, pp. 10-14.
6. Hicks, Bruce and Zielinski. "SEC- A Simulation of Computer Privacy and Security Problems." ISEAC #15, College of Education, University of Illinois, Urbana, Illinois, 1976.
7. Modesitt, Ken. "The Tangled Triangle: Cooperation, Computer-Based Education and Personalized Systems of Instruction." ADCIS Summer Conference, 1976, pp. 320-324.
8. Modesitt, Ken. "Personalized Systems of Instruction in Computer Science: 'Adult' Education." National Conference on Personalized Instruction in Higher Education, 1975.
9. Modesitt, Ken. "An Excellent Mixture for PSI: Computer Science, PLATO, and Knowledge Levels." ACM National Conference, 1974, pp. 89-94.
10. Modesitt, Ken. "PSI: A Valuable Addition to the Alphabet Soup for Computer Science Education." ACM Special Interest Group on Computer Science Education Bulletin, Volume 6, June, 1974, pp. 37-44.
11. Morris, William (editor). The American Heritage Dictionary of the English Language, 1969.
12. North, Robert C. The World that Could Be. Stanford Alumni Press, Stanford, California, 1976.
13. Rhineland, Philip H. Is Man Incomprehensible to Man? Stanford Alumni Press, Stanford, California, 1973.
14. Simon, S. B., L. W. Howe, and H. Kirschenbaum. Values Clarification: A Handbook of Practical Strategies for Teachers and Students. Hart Publishing Co., New York, 1972.

DOCUMENTATION FOR INSTRUCTIONAL APPLICATIONS ON A TIMESHARE SYSTEM

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Application programs written for elementary and secondary students and their teachers are not always self-explanatory. Sometimes a program could get real mileage if the educational setting were understood, capitalized upon, and extended with enrichment activities. For an instructional application to enhance a topic under study, what criteria must the documentation follow to offer pedagogical soundness and be comfortably useful to an instructor? This presentation will address itself to this question and include a documentation outline followed by a statewide educational consortium. Examples of three levels of documentation for the classroom teacher will be presented with the underlying philosophy hypothesized in the need for support materials on an instructional timeshare system.

BACKGROUND

The Minnesota Educational Computing Consortium (MECC) is an organization that began its active services to the educational institutions of the state in the Spring of '74. Three divisions carry out the goals of MECC through Instructional Timesharing, Management Information, and Special Projects.

By means of a distinct communication network equal opportunity is afforded all public school students of the state. Through a system of instructional coordinators based in the Metropolitan area and also outstate, teachers become conversant on the capabilities of timesharing in their classes. To support instructional timesharing a service of publications evolved.

PUBLICATIONS

The quantity and diversity of publications that MECC handles are dictated by the needs expressed by teachers. Individual publications are included in the stock MECC Support Services makes available if the publication satisfies one of the following criteria:

1. a manual that contains programming information for a language on the timeshare system,
2. a teacher/student guide necessary to use intelligently a system library program in a learning situation,
3. a supplementary text or reference that purchased in quantity can be resold to teachers at a substantial cost saving,

4. computer related materials that are inexpensive and qualitatively sound that schools can purchase -- as from a clearinghouse -- for their computer needs.

Henry Ford stated for another product, "If you think of 'standardization' as the best that you know today, but which is to be improved tomorrow -- you get somewhere." This quality control coupled with flexibility permits the list of publications to change --- adding new titles, deleting those rarely requested, updating and re-printing revisions, and adjusting the prices to reflect 'exactly' the cost to MECC of each item. The greatest need for development of materials existed in the area of item #2.

DOCUMENTATION

To meet the needs of elementary and secondary teachers using the timeshare system in class, small group, and individual settings MECC staff compiled documentation on three levels. These levels reflect the scope and breadth of information to support the use of each program on the system library of applications.

LEVEL ONE consists of a Sample Run of each program. A looseleaf notebook of 300 of these Sample Runs, called "A Collection", is one publication available to teachers and initiated by MECC staff. The standards for the programs require that each print out a title and a paragraph of varying length to explain the anticipated benefits and nature of the program. (See examples in Figures 1 and 2.)

TIME : 241 1/8 : 7

FIGURE 1

TIME : .961 1/8 : 4

FIGURE 2

"A Collection of Sample Runs" gives teachers on the elementary and secondary levels a core of programs from which they may select. This publication contains the same information and format that a teacher would get at the terminal, given enough time to run every program in the system library. (It is assumed that the teacher would be knowledgeable about the nature of each program to provide meaningful input data.) This manual is a tremendous time-saver for teachers.

LEVEL TWO takes more time and extends the pedagogical value of each program in the system library. The "Timesharing Program Library Manual" is another looseleaf notebook publication. It began with forty choice programs, selected to cover a variety of disciplines and grade levels. This manual has an update once or twice a year; the update adds thirty programs to the manual and provides a new Table of Contents. In a few years this manual will replace "A Collection of Sample Runs" as it contains a Sample Run for each program plus a first page of information similar to a lesson plan for the teacher. (See examples in Figures 3 and 4.)

With the one-page description of the educational setting of the program the teacher has the material in hand to use the program as an introduction to a topic of study, as the main media for presentation

Name: OREGON

Level of instruction: elementary, middle school, junior high

Subject area(s): social studies, language arts
Specific topic(s): American history, Oregon Trail, pioneer days,
American westward movement, diary writing
Average time for 1 run: 25 minutes

Abstract: This computer simulation takes students on a journey west from Independence, Missouri, to Oregon City, Oregon. Students will make decisions, select resources, and face events as a pioneer on a wagon train in the 1840's.

Instructional objectives:

- 1) To learn the historical experiences relative to travelling west in the mid 1800's,
- 2) To manage limited resources to achieve a specified goal,
- 3) To compare different information sources and determine their accuracy.

User input: As requested: how much to spend at the outset on an oxen team, on food, on ammunition, on clothing, on miscellaneous supplies. Choices of possible responses will be offered the student as the program progresses.

Computer output: Explanation to introduce the program with complete reports each two weeks of travel of progress, changes, state of supplies, unexpected events, and further choices.

Programming language: Real-Time BASIC

Acknowledgement: Don Rawitsch, MECC Instructional Services

Separate documentation needed to run the program effectively? No,
but program is more enriching experience with OREGON (\$.75)
available from MECC.

Supplementary materials:

- 1) WESTWARD ON THE OREGON TRAIL by American Heritage; Harper & Row, 1962.
- 2) NINE LIVES OF MOSES ON THE OREGON TRAIL by Marion F. Archer; Whitman, 1968.
- 3) WHERE THE TRAIL DIVIDES by Lorna Callahan; McGraw, 1957.
- 4) STOUT-HEARTED SEVEN by Neta Frazier; Harcourt, 1973.
- 5) THE FIRST BOOK OF THE OREGON TRAIL by Walter Houghurst; Franklin Watts Inc., New York, 1967.

FIGURE 3

ODELL SIMULATION

Name: ODELL

Level of instruction: elementary, middle school

Subject area(s): science
Specific topic(s): fish, lake environment
Average time for 1 run: 12 minutes

Abstract: A single simulation of a lake environment with five different fish. The user plays the role of one fish and learns of the relationship between the fish as predator and victim.

Instructional objectives:

- 1) To role play several fish.
- 2) To make decisions as a fish to survive.
- 3) To draw up a food relationship between fish.
- 4) To generalize a size relationship between the fish given.

User input: The fish the user will role play and the choice (from five possible stated ones) of behavior.

Computer output: The program will print a list of six fish, the rules of the simulation, and the choices of behavior. The computer will then print a response to the user's choice.

Programming language: Real Time BASIC

Acknowledgement: Unknown

Separate documentation needed to run the program effectively? No, however, suggested activities follow on the next sheet.

Supplementary materials:

- 1) *ALL ABOUT THE SEA* by Ferdinand C. Lane, Random House, New York, 1953, pages 81-92, 94, 97, 99-103
- 2) *FISHES, THE GOLDEN BOOKS OF NATURE* by George S. Fichter, Golden Press, New York, 1963
- 3) "Way of a Trout," 16mm film, color, 30 minutes, (1965), available from St. Paul Public Library (for 15 years and older).
- 4) *MOLECULES TO MAN*, the BBC's Blue version, by Claude A. Welch and others, Houghton Mifflin Company, Boston, 1970, pages 86-77.

FIGURE 4

of the subject content, or as a follow-up/enrichment experience. By means of the list of Supplementary Materials, the last item heading, the instructor may build a complete unit of study around the computer program.

The contents for these pages of information come from several sources: staff members (most of whom are former classroom teachers), teachers who are currently using the programs effectively, previous manuals that contained part of this information (published by MECC or its member systems), and a composite of these three. To facilitate the pooling of this information in the future, a sample form is given to any person requesting that a program be added to the system library of applications. Thus, before a program is considered for inclusion in the system library, its one-page documentation is completed and ready for publication (or at the least, for editing).

Occasionally there is a program included in the Library Manual for which this one-page is adequate for running the program, but for which a page or two of aids could enrich its use extensively. For such programs these extra pages are included in the Library Manual. The program ODELL (see Figure 4) has a reference to an extra page of ideas for using the ODELL program (see Figure 5). Alternatives for this extra one-or-two pages might be a questionnaire (as for a school dating program) or a quiz sheet (as for a drill and-

Teacher Instructions:

1. Divide the class into two groups.
2. Appoint a captain for each group who will be responsible for giving the group decision to you.
3. Instruct each group that they must pick a fish to role play. A rule should be established in the beginning of the game that each group cannot pick the same fish twice if there is a fish that neither group has role played.

4. Start the simulation with Group 1 answering the questions posed by the computer about the fish they picked. Each time the team gets through a situation successfully they get a point.

Points:

- 1 point - for a successful decision.
- 0 point - for a decision which was not the right choice but did not kill them. The team does not get a point but they get to continue.
- 3 points - if they survive the whole simulation.
- loss of turn - if the team's fish dies or gets eaten.

5. Tell the students to take notes on the fish as they go along so they will be able to make better decisions the next round and to answer the questions at the end of the simulation.
6. After the students have gone through the simulation a number of times (as much as time permits), ask the group questions about the fish. The team with the least number of points gets to answer first, then if they miss the other group can answer. The team with the correct answer gets a point.

Possible questions:

- Name the largest fish?
- Name the smallest?
- Which fish is larger - a Dolly Varden or a Rainbow Trout?
- Name a fish that feeds on insects?
- Name a fish that feeds on animal plankton?
- Name a fish that does not feed on insects?
- Etc.

7. Follow up Activities

1. Have students go to the library and find information on the above fish or an osprey or otter.
2. Have students write a report on their findings.
3. Teach the class about food webs and have them draw a food web of Odell Lake.

FIGURE 5

practice on latitude).

LEVEL THREE is a higher form of documentation, where the simulation/exercise requires background information with a description of the model and its behavior along with various supplementary/enrichment narrative. Each program on this level requires a separate booklet of pages from five to fifty, roughly.

For such documentation a set of standards was devised to detail the form and the content. The principle philosophy behind this standardization was a sense of familiarity for teachers in locating and using the information contained within each booklet.

Figure 6 is the substance of a memo sent to prospective authors on the material and content we expect for documentation booklets. In devising this set of standards, the spirit of Sidney Smith's words were observed: "The writer does the most who gives his reader the most knowledge, and takes from him the least time." Within this framework authors organize their content and submit a manuscript that requires little editing and needs only to be re-typed before it is printed in quantity.

The outline for the content of the documentation is as follows:

- 0. Cover
- 0A. Title page
- 0B. Table of contents
- I. Identification
 - A. Subject area(s)
 - B. Specific topic(s)
 - C. Level of instruction
 - D. Role of the computer
 - E. Programming language
- II. Abstract
- III. Rationale for computer usage
- IV. Instructional objectives
- V. Background information
- VI. Description of Model for program and expanded description of program
- VII. Instructional setting
 - A. Buildup and pre-requisites
 - B. Using the program
 - C. Follow-up activities
- VIII. Books, films and other resource materials (Correlations)
- IX. Sample run

FIGURE 6

The sources for the programs on the time-share system library that require a separate booklet to document each are Digital Equipment Corporation (Huntington Two programs), Hewlett-Packard Corporation (GRAZE and INQUIR), the Northwest Regional Educational Laboratory (CRIMEX, ENERGY and FUTURE), Paul S. Amidon Company (WHEELS), and MECC. The first MECC publication enhancing a program on the system library was OREGON, a simulation of a family following the Oregon Trail in the 1850's.

Through a mini-grant project sponsored by Sperry-UNIVAC, MECC added several quality programs to its library with documentation booklets available through its Support Services. The programs developed cover the topics of collective bargaining (BARGAIN), algebraic equation solving (ALGE), diplomatic and military decision-making (FAIL-SAFE), English composition and interpretations (STORY SELECTION AND REACTION), marketing concepts for elementary students (SELLAPPLES, SELLPLANTS, SELLEMONADE, SELLBICYCLES), drill-and-practice in language arts skills for elementary students (SLBP), and pesticides and pest control (PEST).

Each publication printed by MECC Support Services contains a final sheet for "Comments". The special form is in mailer format with a form requesting errata information and suggestions for future printings. Such a provision offers a means of feedback/input for teachers who use the booklet.

LEVELS TWO and THREE represent the quality use of the timeshare system. The availability of such materials justifies and ensures the survival of educational time-sharing.

EDP TRAINING - PERSPECTIVES FROM SAUDI ARABIA

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Like many developing countries, Saudi Arabia has "imported" foreign expertise to meet the pressing demand for data processing education. Faced with an immense cultural wall expatriated educators who have applied, tried and tested methods have returned to their homelands frustrated. Those who persisted have learned pedagogical as well as cultural lessons. These lessons have applications to the educational process in the U.S. for the data processing educator always on the alert for new means of reaching his students.

In the Kingdom of Saudi Arabia the most concentrated EDP training effort to date has taken place at the University of Petroleum & Minerals, an engineering university located in Dhahran. Although the institution cannot boast of unqualified success, the insight gained from the EDP training experience can benefit similar programs in other developing countries and programs in Western institutions that reach out to culturally disadvantaged students. Teaching lessons have been learned that reflect changes in emphasis, new approaches to old problems, and a major change in focus on the student in the learning process.

ESTABLISHING A CULTURAL BASELINE

In technically advanced countries students walk into the EDP classroom with a life full of exposure to abstract problem-solving, industrialization, and a procedure-oriented society. In short, these students step into the classroom from the "computerized society" we have created. On the other hand, the students coming into an EDP training program in a less developed nation bring with them a background virtually devoid of technological exposure. In Saudi Arabia a number of problems are created due to the nature of the student entering the EDP training program.

Problem 1: The overriding disadvantage that the Saudi student brings into the classroom is inherent in the fact that he does not have several generations of life experience with technology. Until the past few decades, Saudi Arabia was completely isolated from Western civilization and life was conducted just as it had been for thousands of years. Technology is new to the Saudi population. Therefore, most Saudis are just now learning to relate to technology as a part of life. The benefits and potential hazards of technology are not yet understood by the average Saudi citizen.

Problem 2: Career roles are not well formulated in the minds of many Saudi students. A career is basically a means of survival in an advanced

society. Until recent years survival came to the Saudi through two major roles - the population consisted of nomadic tribes and merchants. Stenographers, architects, computer programmers, lab technicians, engineers, and so on, are terms that the average Saudi citizen could not relate to until recent years.

Problem 3: Language is, of course, a major problem. Though English is the language of instruction at the University, students conduct much of their thinking through an internal translation process. This, of course, slows down communications in the classroom. In addition, the Arabic language does not have many of the words required to express the concepts and objects of advanced technology.

Problem 4: In Saudi Arabia there exists a general lack of urgency. "Bukra Insha Allah" means "tomorrow, if Allah wills it". In transacting all manners of personal and business affairs "Bukra" is soon enough. As educators we are forced to maximize the use of time - time is of essence to us. We plan, scheme, and manage time. We impose deadlines on our students. We structure our courses around semesters. In Saudi Arabia time constraints are difficult for students to deal with. In some cases, if a student does not learn a concept today, he feels he can learn it "Bukra".

Problem 5: Communications and mobility of the population are common to technologically advanced societies. For centuries in Saudi Arabia a man knew few others than the members of his tribe. Although the tribes were nomadic, they followed the same migration paths. Being an isolated, monolithic population, exposure to people of greatly differing backgrounds is relatively new to most Saudis. Standing in front of a group of students in Saudi Arabia, the Western educator is truly a foreigner. It is very difficult for the student to identify and relate to a person so different from himself when the student has very

little exposure to individuals from diverse cultures.

Problem 6: In most underdeveloped societies many transactions occur at face value, and concepts are often expressed in concrete terms. Abstraction, as a tool of technology, compounds the learning problems in the EDP classroom in Saudi Arabia. The teaching of concepts vis a vis the abstraction underlying the technology is a puzzle of a thousand pieces for the expatriated educator in the Kingdom.

In summary, the role of the Western educator in Saudi Arabia is substantially different from that in his homeland where his basic task was to present data processing content and leave the rest to the student. In Saudi Arabia the major concern of the educator is understanding and meeting his students on their cultural level.

SOME BASIC APPROACHES

One beginning strategy is the realistic establishment of objectives. Within the confines of the institution it must be determined how far the students can be expected to go. Should the EDP training program strive to produce operators, applications programmers, systems analysts, managers, or systems programmers? The University of Petroleum & Minerals established a one-year intensive training program with the goal of preparing students for entry level positions as applications programmers. While the other job titles are important, it was felt that students could achieve this goal, and that the graduates could be productive from the outset once they stepped into data processing shops. As groups are trained and gain work experience, advanced training courses in systems analysis will become relevant. As far as operator education is concerned, on-the-job training was opted for rather than a formal training program.

With applications programming selected as the objective of the training program, strategies had to be developed to overcome the many problems in reaching the students. Below are some of the strategies developed:

Strategy 1: Instruction is problem centered, rather than lecture centered. New concepts are brought up and discussed only as they relate to and are useful for solving new problems. We learned that a lot of "chalk talk" resulted only in a pile of dust and a worn slate.

This key strategy is the basis for the entire program. The computer is a problem solving tool and we were teaching problem solving, not factual material to be memorized and reproduced on some final exam.

Strategy 2: Because the approach we chose was problem centered, the students had to play an active role. We were interested in what the student could do, not what he memorized. The type of performance we were after was the ability of the student to carry out the tasks of a typical applications programmer. Each problem then

represented an applications programming task.

Strategy 3: With the performance orientation we chose we had to be certain that the student could, in fact, carry out each task assigned to him. In order to achieve this result we had to break programming tasks down into small units that students could master easily. For example, in the introductory COBOL course seven minor programming assignments were made and carried out by the students before they were assigned a complete report program with headings, page skipping and numbering, final totals, and so on. Small, evenly spaced steps that build upon previous assignments are essential to the approach.

In the beginning of the course the steps from one programming concept to another had to be many times smaller than those used with a typical EDP class in a technologically advanced country. However, after students gained experience, insight and confidence their ability to progress at more rapid speed and in larger steps improved significantly.

Strategy 4: Although we de-emphasized lecture and traditional classroom discussion in favor of work assignments, we recognized that the students could not be expected to carry out a task without a certain level of knowledge. We chose the use of sample programs as the means to teach a new programming concept that would be required for each new task in the sequence. We present the student with a problem statement, typically a record layout and printer spacing sheet. Then we discuss the techniques of the sample program used to implement the solution to the problem.

There are two disadvantages to this approach. One is that it takes a great deal of work to prepare the specifications, write the sample programs, prepare test data, and so on. In addition, it is essential that each programming assignment differ from the sample to the extent that the sample cannot be merely copied. In spite of these disadvantages, this quite successful approach is a natural learning process because we learn from childhood through imitation. Programmers typically learn new techniques in data processing shops by reading other programmers' codes.

Strategy 5: The performance orientation of the training program requires a significant change in the role of the instructor. The instructor cannot be a lecturer; he must be a manager. The learning we seek depends on what the student can do, not on what he hears and remembers from listening to his instructor "talk". The instructor must step down from his soapbox and function as a manager who must arrange the conditions for learning. He must plan, organize, schedule, and motivate his student "employees". His physical teaching must be limited to the explanation of a new concept or technique required for successful completion of a new task - full stop.

Strategy 6: Strong group relationships are encouraged in the intensive training program. If properly managed so that some students are not too dependent on a few superior students, the peer interaction that results from working together in

informal groups can be a fruitful learning experience. The instructor is too experienced in program development; he takes much for granted and does not have to think through all the details of a problem in the same manner as his students.

Working closely in groups, students communicate their proper conceptions and misconceptions in their novice terminology. Through such interaction a great deal of learning takes place. However, there is the danger of blind reliance on other students in carrying out assignments. This potential learning hazard can be handled by making the students fully aware that testing and evaluation is strictly individual, as it must be.

Strategy 7: Group interaction solves much of the language problem discussed earlier in this paper. New concepts expressed in foreign words often become clear as they are discussed among the members of the group. Another approach to the language problem which is used in the intensive training program at the University of Petroleum & Minerals we have labeled as "animated transparencies".

Rather than use words to discuss the actions taken by the computer in response to program instructions, an animated transparency allows the instructor to show input, processing, output, and the value of data items as a result of each instruction in a program. A transparency illustrating data, a program loaded into the CPU, and output is projected on the chalkboard. Students are called to the board to "execute" the program. The current record being processed, values of counters and accumulators, and printed results can be seen as the process of execution occurs. Students see the effects and results of programming techniques rather than having to rely on a meaningless discussion with words alone. Details of the use of this teaching medium are documented in the article titled "The Use of Animated Transparencies for EDP Training".

Transparencies can also be very useful in arranging effective feedback and discussions regarding programming solutions developed by students. The compiler and computer test runs provide immediate feedback on the correctness of a program. However, the students need feedback on the programming techniques chosen to solve a problem. Rather than the instructor standing in front of the class and showing his preferred approach, better student programs can be selected and transparencies made from them. With no prior notice, a student will look up to see his program projected five feet tall on the board. He will be called upon to explain his approach and coding techniques to the rest of the class. Discussion and student critiques flow freely as the work of a peer - not a master or expert - will be the basis of evaluation. Extremely poor coding techniques also can be presented to the class in this way. However, student identity must be concealed, as ridicule and negative reinforcement are of no value. This means of illustrating

poor coding habits or techniques should be used with reserve to point out common coding weaknesses.

Strategy 8: Testing and evaluation must follow the teaching approach. Traditional tests - multiple choice, fill in the blank, matching, and so on, are of little value. The learning approach we have discussed has been based on specific performance, and testing must follow suit. The typical "test" in the intensive training program consists of a one day block of time set aside where the students are given a set of program specifications and asked to develop the source program.

Source programs are collected and graded according to stated criteria that include correctness, programming technique, and efficiency. Students are required to work independently. They are given coding sheets, flow charting template, and a reference manual as resources.

Strategy 9: One final consideration in developing effective learning resources is the evaluation and selection of textual materials. Too often textbooks used in academic programs in advanced countries are so culturally different in content and use of language that they are likely to be very difficult for students in developing countries to read and understand.

One alternative to the use of standard texts is to develop in-house texts or materials. This alternative requires huge resource and manpower commitments on the part of the institution. A better approach is to select standard texts on the basis of readability rather than content. With a readable text in hand it is easy to enhance or supplement content with materials produced in-house. Unless accomplished authors are on board at an institution it is in the best interest of the students to select the most easily readable texts available. A survey of business data processing texts documented in the Journal of Educational Data Processing determined that one book on the subject was so extremely readable that it was categorized in a group all to itself.

CONCLUSIONS

The student entering the EDP classroom in Saudi Arabia typically has no personal identity with either technology or the foreign instructor standing in front of him. In the preceding pages the learning problems and strategies for overcoming those problems have been highlighted.

What is the major tie between the problems and strategies as stated? The answer is quite simple. The key to overcoming the cultural problems inherent in the learning situation is motivation - motivation through achievement. The cultural differences between

the instructor and the learner are so great that the only basis for student progress is student achievement through performance.

Wearing thobes and gutras (traditional Saudi dress) and speaking fluent Arabic with a Gulf dialect could never bridge the learning gap between the Western instructor and Saudi student. The most important task for the instructor in this situation is to arrange the conditions for learning - learning based on active performance. By meeting the student where he is and taking him through very small initial steps the EDP classroom in Arabic can become a workshop for successful EDP training.

The instructor's role must change from "talker" to "listener"; from "teacher" to "manager". He must plan, implement and revise strategies based upon continuing student feedback. In short, the instructor must make a total commitment to an activity centered learning process, rather than traditional teaching.

THE FUTURE

Technology will become more and more commonplace as Saudi Arabia continues to rush toward industrialization. As this occurs, students entering EDP training programs in

the Kingdom will possess a background similar to the students in today's industrialized societies. Meanwhile, the EDP instructor will be faced with a most challenging learning situation. Those educators who choose to accept that challenge will stand to gain insight that will substantially change their outlook on the teaching-learning process.

In Saudi Arabia government and educational leaders have achieved much in making educational opportunities available to the youth of the Kingdom. Much of this effort has been oriented to technology in an attempt to leapfrog the development process in the country. Several thousand Saudi students are presently being educated abroad. In turn, foreign educators are commonplace in Saudi educational institutions.

The Saudi leadership clearly recognizes that industrialization and self-sufficiency depend on the development of a sound technistrucre which can only be achieved through successful educational programs. With the computer being the cornerstone of technology, data processing education in the Kingdom must be effective. This effectiveness will depend on the continuing improvement of the EDP training programs and the commitment of the people responsible for those programs.

EMPIRICAL MEASURES OF THE USEFULNESS OF A COMPUTER-BASED BUSINESS GAME IN THE POLICY COURSE

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ABSTRACT: This article describes a six-year experiment with the use of a business game as a supplement to the usual textbook cases in the Policy course. The data base comes from experimental data gathered in six years of teaching the course with and without the game, from surveys of student opinion, and from a survey of graduates who are now on the job. Statistical and judgemental analysis of the data show that in this experiment the game has been a useful, valid, and valuable addition to the case studies usually used in the Policy course.

INTRODUCTION

The Problem

Can a computer-based business game be a useful addition to the Policy course to achieve certain objectives? That is, can it be useful for the teacher, the student and the graduate on the job? This paper describes the author's attempt to answer these questions during six years of teaching the Policy course at the California State University, Sacramento (CSUS).

Background

Those who use business games as instructional aids are frequently accused of using them uncritically, and failing to measure their effectiveness. Neuhauser's recent critique in the *Academy of Management Review* (4) is a case in point. The author of this paper agrees with Neuhauser that measurement of effectiveness of business games is truly needed, hence this paper describes an attempt to assess the effectiveness of a game used in the Policy course during six years of teaching the course to seniors at CSUS.

As readers are aware, there are many pros and cons about the usefulness of games in education, particularly in business courses, where their use is very widespread. Business professors have evidently studied the question more thoroughly than others, as Neuhauser's references show (4:128-29), and as the references of Boseman and Schellenberger also show (1:401-02), but much remains to be

done before the weight of evidence is on one side or the other.

Raia's trail-blazing study (5) set enviably high standards for testing the effectiveness of games in business courses, but the experiment "has not been replicated" (4:125). Boseman and Schellenberger (1) did replicate portions of Raia's experiment, but did not address the value of simple versus complex games, so Raia's important finding that a simple game is as useful as a complex one in the Policy course stands unchallenged as a guide for those who might wish to use games in the course.

Objectives Sought in Using a Game

Boseman and Schellenberger (1) make the very cogent point that the effectiveness of games should appropriately be measured by comparison to the objectives sought in using the game. Their comments led the author of this paper to try to determine if the game achieved the very limited objectives he had sought in using it.

Simply put, the author's objectives in using a computer-based business game in the Policy course were to: 1) provide the students with a realistic case in which they could have access to all the data they could hope for, and 2) to oblige the students to deal with and understand the use of quantitative control data (figures). These objectives grew out of the realization that undergraduate students often regard the usual textbook cases as not fully realistic, and perhaps distant from their own experience and goals. Many also feel that in a "real-world" situation they

would be able to get much more data than the casewriter presents. At the same time, undergraduate students show a certain reluctance to deal with quantitative data, even when present in a case. They seek to speak and write in generalities which do not subject them to the need for detailed and specific defense of their positions. This propensity tends to weaken their analyses of textbook cases.

As one approach to the problems just mentioned, the author began to use a business game to supplement textbook cases during the third semester of teaching the Policy course. It was assumed that the peer group competition inherent in a game would give a sense of involvement in a realistic management situation in which the students could get all the data they wanted, and would be obliged to deal with figures to compete at all.

To test the above assumptions, Model 2 of The Executive Game (2) was introduced during the third semester of the teaching of the course. This game seemed to the author to strike a balance between complexity and simplicity which was well suited to achieving the objectives sought. The game was continued through the 9th semester, dropped in the 10th to test the effect of dropping it, and reinstated in the 11th and 12th semesters. The results of this experimentation are discussed below.

RESEARCH METHODOLOGY AND DESIGN

Methodology

Initial assumptions were: 1) although an earlier study (3) had shown evidence that the game was useful to teacher and students in achieving the objectives, and some scattered reports from graduates had supported that finding, further research was warranted; and 2) a survey of students, a survey of graduates who are now on the job, and an updating of the previous data should provide a fuller and more reliable basis for evaluation and for planning future conduct of the course.

The investigation covered:

1. Statistical data comparing grades with and without the use of the game, and comparing grades with rank in the game.
2. Students' opinions on the usefulness of the game in the course.
3. Graduates' opinions about the usefulness to them on the job of the lessons learned from the game in the Policy course.

The investigation was restricted to the 12 semesters that the author taught the course at CSUS, and to the 316

students and graduates of that course. The time covered is from 1970 to 1976.

Design of the Study

The study was designed to provide statistical and qualitative data for analysis.

Game Administration. The game was used in several ways. First, it was simply used as an adjunct to the course to accomplish the basic objectives, and it was treated as a discussion case. As usefulness became more evident, the game was more thoroughly integrated into the course, ultimately being used as the basis for very practical mid-term and final examinations. (Note that formal textbook cases were always used as the core of the course.)

As the experiment finally developed, the students were required to play through eight quarters and prepare two annual reports, one after the fourth quarter and the other at the end of the eighth quarter, as mid-term and final examinations. They represented the first annual report of operations to the Board of Directors, and the second annual report of operations to the Board of Directors. The plans for future action which were recommended in the first annual report were executed in the second year of the game, and the effectiveness of these actions was appraised and reported upon in the second annual report. An analysis of the play of the students' first four quarters was conducted by the instructor before the students' first reports were due, and a similar analysis of the play of the fifth to eighth quarters was conducted before the final report was due.

Data Collection. The data were collected from the course records, computer runs of the game, and recordings of observations. In addition, students in the last two semesters were asked questions about the usefulness of the game in the course (there were 63 respondents), and all 316 graduates of the course were included in a survey which asked if the game was helpful on the job. The latter survey is still in progress, but preliminary data are available and are cited in this study.

RESULTS

Data on Student Grades

The data below were extracted from grade books and computer print-outs resulting from the play of the game.

Comparison of Final Grades with and without the Use of the Game. Final grades

in all 12 semesters of teaching the Policy course have been compared to determine if there is any significant difference between the class averages when the game was played and when the game was not played. Table 1 below shows the results of the comparison.

Note on Table 1 that in the classes where the game was not used, the average final grades were higher than those in which the game was used. However, the motivation and aptitudes of the Fall 1975 students were clearly lower than during other semesters, and they stayed low in spite of efforts to bring them up to standard. The results that the students obtained show this. Omitting the Fall 1975 group from the averages for the first 11 semesters yielded the interesting result that there was no difference whatever in grade averages when the game was used and when it was not. When the results from the 12th semester are added to the data, as they are in Table 1 below, the result is nearly the same; but there is a slight difference which is not significant. These data are in line with the findings of Raia (5), Bosenan and Schellenberger (1).

TABLE 1
Comparison of Final Grades with Rank in the Game

Semester	Game Used	Game Not Used	Game Used	Game Not Used	Game Used	Game Not Used	Game Used	Game Not Used	Game Used	Game Not Used	Game Used	Game Not Used
1968-69	75.0	78.0	76.0	79.0	77.0	80.0	78.0	81.0	79.0	82.0	80.0	83.0
1969-70	76.0	79.0	77.0	80.0	78.0	81.0	79.0	82.0	80.0	83.0	84.0	85.0
1970-71	77.0	80.0	78.0	81.0	79.0	82.0	80.0	83.0	81.0	84.0	85.0	86.0
1971-72	78.0	81.0	79.0	82.0	80.0	83.0	81.0	84.0	82.0	85.0	86.0	87.0
1972-73	79.0	82.0	80.0	83.0	81.0	84.0	82.0	85.0	83.0	86.0	87.0	88.0
1973-74	80.0	83.0	81.0	84.0	82.0	85.0	83.0	86.0	84.0	87.0	88.0	89.0
1974-75	81.0	84.0	82.0	85.0	83.0	86.0	84.0	87.0	85.0	88.0	89.0	90.0
1975-76	82.0	85.0	83.0	86.0	84.0	87.0	85.0	88.0	86.0	89.0	90.0	91.0
1976-77	83.0	86.0	84.0	87.0	85.0	88.0	86.0	89.0	87.0	90.0	91.0	92.0
1977-78	84.0	87.0	85.0	88.0	86.0	89.0	87.0	90.0	88.0	91.0	92.0	93.0
1978-79	85.0	88.0	86.0	89.0	87.0	90.0	88.0	91.0	89.0	92.0	93.0	94.0
1979-80	86.0	89.0	87.0	90.0	88.0	91.0	89.0	92.0	90.0	93.0	94.0	95.0
1980-81	87.0	90.0	88.0	91.0	89.0	92.0	90.0	93.0	91.0	94.0	95.0	96.0
1981-82	88.0	91.0	89.0	92.0	90.0	93.0	91.0	94.0	92.0	95.0	96.0	97.0
1982-83	89.0	92.0	90.0	93.0	91.0	94.0	92.0	95.0	93.0	96.0	97.0	98.0
1983-84	90.0	93.0	91.0	94.0	92.0	95.0	93.0	96.0	94.0	97.0	98.0	99.0
1984-85	91.0	94.0	92.0	95.0	93.0	96.0	94.0	97.0	95.0	98.0	99.0	100.0

It appears from the above data that the game in no way detracts from the ability of the students to achieve grades consistent with what they would achieve without the game.

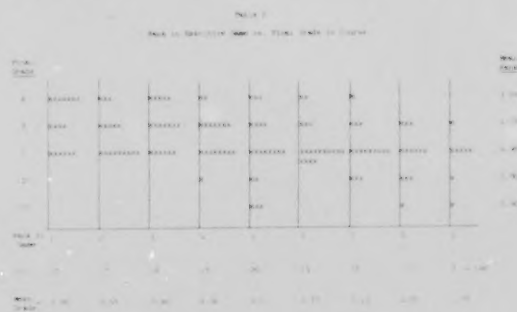
Comparison of Final Grades with Rank in the Game. Table 2 below compares the students' final grades with the rankings that they achieved in The Executive Game. The data were gathered over the last five semesters in which the game was used. The sample covers 146 students.

Ranking in the game is determined by the rate of return on owners' economic equity. The final grade in the course

is not influenced in any way by the rank in the game, and no points are given or taken away for high or low performance. The final grade is made up of analyses and reports upon 6 to 12 cases plus grades for classroom attendance and participation. The report upon the game is but one of the cases, except in the last semester, when two reports were required (as mentioned earlier.)

Keeping in mind that rank in the game forms no part of the final grade, note in Table 2 below that there is a clear correlation between high rank and achievement in the business game and high final grades. Likewise, low final grades correlate with low rank in the game. This suggests that the game is a valid addition to the Policy course, tending to give results which are consistent with other achievement, and perhaps measuring the same things.

Statisticians say that the data on Table 2 are not amenable to statistical tests such as multiple regression or Spearman's rank correlation, but they claim that inspection clearly shows the correlation.



Observational Data

The business game was introduced into the third semester of the course to accomplish two things: 1) to give students a sense of reality and involvement in a realistic management situation; and 2) in that process to oblige them to deal with and understand figures.

The results were gratifying. Because of a greater sense of realism, and because of the competition, the students became involved personally in the game. A rapport among the students developed which had not been there before. Moreover, most of the students began to understand and to deal with figures, ratio analysis, the need for forward planning and control, and the need to gain all the information they could about the competition and the "external environment."

The game continued from the third through the ninth semesters. It was dropped during the tenth semester and there resulted a noticeable drop in class spirit and motivation. Reinstated in the 11th and 12th semesters, the game resulted in greater motivation.

The statistical and observational data above suggest that the game is useful for teacher and students alike, and that it is a valid addition to the course.

Data from Student Survey

As mentioned above, a key objective of the game was to oblige the students to deal with figures for their own companies and their competition in order to do forward planning in a realistic setting. The students in the 11th and 12th semesters were surveyed to determine if that objective had been achieved. Responses were received from 63 students.

The following three statements were made in the survey and the students were asked to respond on a scale from 1 (not at all descriptive) to 5 (very descriptive). The mean, mode, and median are shown for each item.

	Mean	Mode	Median
1. The Executive Game was helpful to me in learning to analyze business statistics in an actual problem setting.	3.83	4	4
2. The Executive Game gave me insights into business data for analyzing the actions of competitors.	3.57	4	4
3. The Executive Game was helpful to me in learning the importance of planning.	3.68	4	4

The data above show clearly that the game accomplished the important objectives sought by the instructor, plus others, and was also useful to students.

Data from Survey of Graduates

A questionnaire was sent to each of the 316 graduates of the Policy course taught by the author. Early returns have been received from 84 graduates as of this writing, whose final grades ranged from A to D with the mode at C. The results of these early returns appear below. Each graduate was asked to respond to a statement on a scale from 1 (strongly disagree) to 9 (strongly agree). Those statements appear below, together with the mean, mode, and median of the responses.

The data show clearly that the game accomplished the important objectives sought by the instructor, plus others, and was also useful to the graduate. These preliminary data also strongly suggest the validity of the use of the business game

in the Policy course, i.e. it appears to relate truly to the job for which the student was training.

	Mean	Mode	Median
The Executive Game has helped me on the job			
a. To understand the need for planning	3.83	4	4
b. To understand the importance of forecasting	3.68	4	4
c. To understand the organization where I work	3.57	4	4
d. To know how to analyze data about competitors	3.54	4	4
e. To appreciate the interrelationships between forecasting, marketing, production, inventories, R & D, and fixed and variable expenses	3.84	4	4
f. To understand and use control data	3.86	4	4

CONCLUSIONS

1. The game was useful to the teacher because it accomplished the objectives for which it was intended, i.e. the game: 1) generated added interest in the course by providing realism and ample data in a case that was not simply vicarious, as are textbook cases; and 2) obliged students to analyze and use figures effectively. Further, the game did not distort the usual grade structures and it produced rankings of performance which were consistent with the grades assigned by conventional methods.

2. The students reported that the game was useful to them in the three critical areas in the survey--using figures, planning, and keeping up with the competition--all related to the objectives sought.

3. Finally, the graduates reported that the game was useful to them on the job in helping to understand key aspects of management. Apparently the benefits went well beyond the simple objectives sought in using the game in the course.

All in all, the computer-based business game is a valid and valuable addition to the usual textbook cases which are used for the course. Certainly, it appears worth the time of other instructors to experiment with such a game to determine if they find the same or similar helpful results in their own settings.

REFERENCES

1. Roseman, F. Glenn, and Robert F. Schellenberger. "Business Gaming: An Empirical Appraisal," *Simulation and Games*, Vol. 5, No. 4 (December 1974), 303-309.
2. Wendlow, Richard F., Jr. and James R. Jackson. *The Executive Game*. (Homewood, Ill.: Richard D. Irwin, Inc., 1972).
3. Kaufman, Frank L. "Computer-Based Business Game in Senior Collegiate 'Capstone' Course," *Today's Revolution: Computers in Education*. Proceedings of the International Convention of the Association for Educational Data Systems, 1970, 211-235.
4. Weinbauer, John G. "Business Games Have Failed," *Academy of Management Review*, Vol. 1, No. 4 (October 1976), 124-125.
5. Hale, Anthony P. "A Study of the Educational Value of Management Games," *The Journal of Business*, Vol. 39, No. 3 (July 1966), 317-330.

ISSUES IN THE INSTRUCTION OF
INTRODUCTORY COMPUTER PROGRAMMING

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This study investigated the effects of (a) varying curriculum organization, (b) providing computer generated reinforcement and (c) differential error diagnostics to 155 Ss learning to program a computer.

Analyses indicated that learning an assembly language before a high level language yields higher achievement scores than vice versa. No significant differences or trends were noted in learner performance as a result of providing on-line reinforcement or coded versus English-like diagnostics in the inter-active learning sessions. These findings substantiate the belief that terminal users prefer to have the computer find program errors through increased interactions than to carefully plan to avoid errors.

CURRICULUM SEQUENCE EFFECT
IN COMPUTER SCIENCE COURSES

The topic of logical ordering of curriculum material has been examined by those concerned with the importance of behavioural objectives in curriculum design (Edling, 1968; Miles and Robinson, 1971; Moore, 1969). Despite such research, a survey of various introductory secondary school computer science curricula indicates little uniformity in the sequence of content in computer science courses. An outline of topics does indicate a general agreement in the nature of the content. In no particular order the topics are:

- a. Assembly language programming and associated principles of computer architecture.
- b. High level language programming.
- c. Other uses and effects of computers in society.

Unfortunately, data indicating an optimum hierarchical sequence, either between or within these topics, are non-existent. In particular, it is the sequencing of the first two of these topics which was one of the concerns in this study.

*The research described in this paper was performed by the author before his employment with IBM Canada.

Textbooks which are often used as curriculum guides do not assist us in this sequence problem for the reason that there are many books representing both views. In any case, Gagne (1967) concludes that in many instances, textbook topics and sequences seem to be unrelated to the sequences suggested by task analyses. Traditional secondary level computer science curriculum guides offer no support for choosing a particular sequence and instead leave the choice up to the practitioner.

The fact is however, that no general optimum sequence may exist. Instead, the selection of an optimal sequence may be made, not for a group, but instead for the individual student.

The literature seems to indicate that for some instructional materials, this may be true. Cronbach and Snow (1968) suggest that for a given task, alternative methods of instruction exist which differentially affect learners of different aptitudes. Snow states that "for low ability Ss, instructional treatment must be arranged to provide stimulus differentiation facility that is missing. For high ability Ss, the treatment must provide the associational attitude that is preferred" (Snow, 1969, p. 7). Once identified, these aptitude by treatment interactions (ATI's) can be used to choose the proper instructional treatment for the individual.

In order to apply such principles in a practical environment, or in fact even to investigate the viability of this theory, it is necessary to determine the nature of student aptitudes and their relationship to characteristics of each particular subject matter. A careful examination of the characteristic of the curriculum related to low level languages, (assembly language and associated computer architecture) and high level languages (symbolic Fortran-like material), and a corresponding review of ATI literature suggested that students who learn low level concepts before high level concepts, would perform better on selected criterion measures than students who learn high level concepts before low level concepts.

A second hypothesis investigated concerned possible interactions between curriculum sequence and student aptitude. Specifically, that the low level/high level sequence would be more effective for low verbal ability students than the opposite sequence, and for high verbal ability students, this effect would be less noticeable.

THE NATURE OF FEEDBACK IN COMPUTER PROGRAM DIAGNOSTICS

With the increasing use of smaller computers in instructional environments, there is a corresponding reduction in storage available for error diagnostics.

In this event, minimal diagnostics are provided to the student programmer to correct his program. This situation is an obvious contrast to the classroom situation, where the instructor attempts to provide the learner with an optimum amount of feedback and reinforcement to ensure learning of the principles being taught. Gagne (1965, p. 268) specifies the provision of feedback as an essential component of the instructional environment.

It was the author's argument that the nature of feedback provided to the student in a programming situation is beneficial and will assist the student in learning the principles of programming in a more efficient manner. Specifically, it was hypothesized that, with a student program, increased informational feedback provided with error diagnostics, and the addition of reinforcement in the feedback, would aid the student while he is learning the principles of programming languages. As a result, students would successfully complete programming tasks in fewer runs than if there

were less information and reinforcement in the feedback.

HYPOTHESES

The study attempted to determine the effect of learning to program:

- a) By learning a high level language and then a low level language (Group HL), or
- b) Learning a low level language and then a high level language (Group LH).

In addition, the effect of providing students with different amounts of information in computer generated diagnostics was investigated. The error diagnostics provided were:

- a) A numeric code (Group E1).
- b) A condensed English statement of the error (Group E2).

The reinforcement conditions were:

- a) No extraordinary reinforcement (Group R1).
- b) Reinforcement, consisting of a list of computer generated statements of the concepts the student used correctly (Group R2).

METHOD

The above hypotheses were tested in two studies. One was conducted with 43 graduate students and the second with 113 grade 10 secondary students from three schools. None of the students had any previous computer background.

Two independent program instruction materials were designed and thoroughly field tested; one set to teach the low level language (LLL) concepts and the second the high level language (HLL) concepts. Each S was assigned to Group HL or LH. Within each sequence, S was assigned randomly to each error condition (E1 or E2) and then to each reinforcement condition (R1 or R2).

Ss in Group HL were administered instruction first in HLL and then in LLL and Ss in Group LH received instruction in LLL and then HLL.

The instructional treatments were administered to the Ss in their classroom groups. Following the instruction, each S's group was administered a computer administered performance task. At that time, he was presented with a review summary

of his previous instructional session followed by a controlled interactive programming assignment/test. When this was completed the groups were reconvened and Ss were administered the second PI manual. Each S then followed a similar procedure as for the first half of his treatment.

After the second performance task had been administered to all Ss, the groups were reconvened and administered a 46 item pencil and paper post-test.

INSTRUCTIONAL MATERIALS

The following two examples illustrate the HLL and LLL components taught in the PI manuals and used for in the interactive programming tasks.

a) High Level

```
SET R1=REAL #1
SET R2=REAL #2
SET I1=INTEGER #1
SET R3=REAL #3
SET I2=INTEGER #2
WRITE N,R1,R2,I2,R3,I1
N FORMAT (Fa.b,Fc.d,Im,Fe.,In)
```

b) Low Level

```
CREATE INTEGER #1
STORE A
CREATE REAL #2
STORE C,D
CREATE INTEGER #2
STORE B
PUT A
PUT B
PUT C,D
```

ANALYSES

Two groups of variables were defined to test the hypotheses. These were classified as performance and achievement variables. Performance variables were calculated as summary data from the Ss' performance on the computer administered programming tasks. Achievement data were various subscores obtained on the post-tests. An additional measure, called learning efficiency was defined as the total post-test score divided by the total time to complete the programming tasks.

The analyses for the secondary and graduate students were performed separately. An analysis of covariance for each group was performed. For the graduate students, the covariant used was Miller Analogies test scores and for the secondary students, General Aptitude as determined by the SCAT. An analysis of covariance on the main effects and second order interactions of sequence, error, and reinforcement was performed.

RESULTS

A. Sequence Effect

Only some of the independent measures reached significance at the .05 level or better; and, most of those that did not, still favoured the low/high sequence over the high/low one. Although the differences were minimal, it may be true that these results would be more pronounced in a more general computer science curriculum extended over a full school term. An interesting observation is that all subjects did better on the material which they learned second. This seemed to indicate that from the first task, Ss learned how to learn more effectively on subsequent tasks of a similar nature. This phenomenon was more effective if the LLL material preceded the HLL material. Another explanation of this might be attributable to the longer time interval between the learning of the first material and the final test, than the time interval between the second material and the final test. It is likely that the data are a reflection of both these explanations.

In order to probe the sequence effect in more detail, a questionnaire was distributed to all Ss to determine their preference for the order of material.

Of the LH Ss, 70% thought that the LH sequence was the better order to learn the material. Of the HL Ss, 82% thought that the LH sequence might be better.

Almost all Ss of both groups agreed that the computer sessions had helped them to learn the material. The results all indicated that the LH Ss found their sequence less difficult than did HL Ss.

In summary, the LH group did not experience any more difficulty with the first material than the second, as opposed to the HL group, which found the first material to be more difficult.

B. Interaction Effect

The hypothesis predicting that low verbal aptitude Ss would do better on the LH sequence than on the HL sequence and that the high verbal aptitude Ss would do equally well on either sequence, was not directly supported by the analyses. Trends existed but were too small to be conclusive; however, a measure containing both verbal and mathematical aptitude was highly correlated with final test results.

This suggests that general aptitude might be a successful measure for predicting success in introductory computer science courses.

C. Error Diagnostic Effect

No significant differences were found for this effect. This probably resulted from the fact that the net information difference between the E1 and E2 treatments was minimal. In any case, subjects seemed to disregard the content of either error message and in the interactive mode, attempted to debug their code with less discrimination than they might in a batch programming mode.

D. Reinforcement Effect

No significant differences were found for this effect. This might be attributable to the fact that there was none of the "personal touch" usually found in typical CAI or PI reinforcement situations. This was intentional. The diagnostics were designed to be impersonal so that if any significant effect were found, the results could be generalized to batch programming, an impersonal programming environment. Thus the reinforcement had only had a large information component and a small motivation component. It may be concluded that there was little need for additional external motivators in this particular computer task. The computer work itself was self-motivating.

E. Student Reaction

A rather interesting phenomenon was the reaction of the Ss to the experiment. Many of the graduate students were overtly antagonistic and hostile to the computer and often frustrated by the generation of error diagnostics. It was only because they had promised to participate in the complete study that most of them returned for the remaining sessions.

However, most of the grade ten students greatly enjoyed the overall experience and were eager to continue and return to each additional session. Most seemed sorry when their computer session terminated - in obvious contrast to the graduate students. Many comments written on the back of the questionnaires indicated that the students enjoyed the experience and intended to consider Computer Science as a subject to study in the following year. It is note-worthy that of all the 165 subjects that started in the study, 155 completed it. Considering that each S was required to complete approximately 6 one-hour scheduled

sessions, this was an amazingly low attrition rate. The expectation had been for a 30% attrition rate.

CONCLUSIONS

- a) Students performed better overall when they learned low level computer programming concepts before high level.
- b) Given the opportunity to select the sequence of LH or HL, students preferred the LH.
- c) General aptitude was a better predictor of overall success than was verbal or mathematical aptitude, or mathematics or English grade.
- d) There was no discernable effect in overall performance if students received codes or statements as error diagnostics.
- e) There appeared to be no differences in overall performance if students received a computer generated reinforcement when programming, as opposed to the traditional mode of no reinforcement.
- f) Most students felt that programming on a time-sharing terminal was a useful aid in learning the programming material used in this study.

REFERENCES

- Cronbach, L.J., & Snow, R.E. Project on individual differences in learning abilities as a function of instructional variables. U.S. Office of Education School of Education, Stanford University, annual report no. 2, 1968.
- Edling, J. Educational Objectives and educational media. Review of Educational Research, 1968, 38, 177-194.
- Gagne, R.M. The conditions of learning. New York: Holt, Rinehart & Winston, Inc., 1965.
- Gagne, R.M. Learning and individual differences. Columbus, Ohio: Merrill Books, Inc., 1967.
- Miles, D.T. & Robinson, R.E. Behavioral objectives: an even closer look. Educational Technology, 1971, XI, 39-45.
- Moore, J.W. Instructional design: after behavioral objectives what? Educational Technology, 1969, IX, 45-49.
- Snow, R.E. Aptitude-instructional treatment interactions: selected findings and hypotheses. Paper given at the 1969 AERA Convention, Los Angeles.

PROGRAMMING EXERCISES AS CURRICULUM INTEGRATORS

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When computer programming exercises are assigned by teachers, the instructional value of the exercise content is too frequently overlooked. If the solution of these exercises required knowledge about other disciplines, students could obtain additional benefits: the exercises would introduce the students to a variety of realistic applications and they would obtain a better understanding of the processes (from other disciplines) that they programmed. This paper presents several examples of "multi-disciplinary programming exercises," a rationale for their use, and a list of desirable characteristics for good exercises.

Courses in computer science, data processing, or other areas that involve the learning of computer programming often require the student to complete programming exercises. These exercises give the students practice in translating some process into a set of computer commands that accomplish the same process. Very often the exercises are relatively "content free" (write a program to add a set of numbers...) and the objectives attained by the exercises are relatively in the data processing, computer science domain. This paper is based on the assumption that the content of programming exercises is typically an unutilized resource; that content could be designed that would facilitate learning in other subject matter areas without jeopardizing the attainment of the programming goals.

The value of linking programming exercises to other areas of curriculum should not be underestimated. In programming a process the student must "translate" all the steps into some computer language and set up the correct sequence of steps for all possible occurrences. In so doing, the student is "explaining" the process, albeit to a machine. Nevertheless, the exercise of explaining a process to someone or something is a powerful instructional tool.

Also, there is the advantage that students get experience with computer science as an applied science. Probing the interface between computer science and other disciplines not only will be good experience for later work with colleagues from various fields, but should also enhance, by providing multiple views, students' understanding of computer science concepts.

On the basis of this rationale, a number of exercises were produced by students in course 1516XS - "Programming Applications in Ontario Curricula" - offered in the summer of 1974 at the Ontario Institute for Studies in Education. This course had been defined some two years earlier in response to frequent requests from teachers for strategies to be used in teaching about computers and complaints from the same group about an inadequate supply of interesting programming exercises. The result was a course with some materials on teaching about computers, but with a wider scope, as illustrated in its title, of considering programming applications in all curriculum areas.

Among the 1974 students in 1516XS there were four who taught about computers, four who taught mathematics, and four who taught in other areas. During the six weeks that classes were in session, the students worked in groups of three, each group including each of the three types of teachers: computers, mathematics, and other. Each of the groups prepared at least two programming exercises during the course, and as a final project each student prepared at least one exercise of his or her own. Altogether a total of 27 exercises were prepared.

In describing their programs, most students used a list of "categories of programming complexity" developed in a previous section of 1516X taught by Professor Robert S. McLean in the fall term of 1973/74. The categories included data structures, manipulations, storage of elements, structure of programs, logical constructs, input, output, program size, and machine dependency.

CRITERIA FOR THE PROGRAMMING EXERCISES

After each of the groups had prepared one exercise, a consensus set of criteria for programming exercises were developed and were divided into groups on the basis of their perceived importance.

For a good programming exercise (with non-mathematical content) the following criteria were judged most important.

- Relevant to the current and potential interests and abilities of the student, particularly interests which can be related to curriculum guidelines and bulletins from non-mathematical areas.

- Relevant to the programming skills that the student has acquired or should acquire in the programming course.

(In the previous two criteria, there is additional value if the concepts which must be utilized, both programming and non-programming, are difficult for students to grasp and hence worthy of the extra attention.)

- Suitable for students of various ability levels (probably accomplished by varying the amount of solution furnished to the student and by offering optional sub-exercises).

- Appropriate for a variety of computer installations, particularly those operating in batch mode with small computers (IBM 1130).

- Stated clearly and concisely so that there can be no misunderstanding about the program which is required.

- Stated to include a list of the information and abilities that are required to accomplish the task(s), possibly including references for the non-programming information.

The next group of criteria was judged less important.

- Written in such a form that the minimal requirements are spelled out in the greatest detail, and the options are stated more briefly.

- Documented to include a model solution, which specifies an acceptable answer but allows the possibility of better solutions.

- Designed to include an evaluation scheme which points out the key items that should be contained in an acceptable solution.

The last group of criteria was judged least important.

- Not likely to raise objections from the staff members who teach in the non-programming area.

- Designed to result in the programming of a non-trivial algorithm.

- Provided with a set of test data (or a means of generating test data) so that students may test their programs.

- Described to include an estimate of the time required to complete the project and/or the major components.

THE PROGRAMMING EXERCISES

From the 27 programming exercises that were produced, 10 were selected to be put into a book, "PROGRAMMING PROJECTS ACROSS THE CURRICULUM: TEN PROTOTYPE EXERCISES." They were selected because they were among the best and also because they represent a variety of approaches. One of the most important features that distinguishes the approaches is the number of students that would normally be involved in working on the exercise. Many of the exercises could be assigned to individuals or small groups, while some of them are specifically designed for group assignment. Descriptions of the exercises follow. The descriptions are necessarily brief and general, dealing primarily with the form of the exercises rather than specific details.

The first two exercises by Jim Breadner illustrate the possibilities of varying the group size. In "Survey Result Tabulation" the programming task is quite small compared to the effort required to prepare questionnaires and gather data. This implies that a teacher other than the computer science teacher would be giving considerable support to this project. On the other hand the "Consumer Credit Program" is an exercise designed for a programming team of seven students and requires relatively little effort on the part of other teachers who might be involved. (It should be noted that although Breadner is the only author to require the chief programmer team concept as part of the exercise, there are several other exercises where this concept could be applied with beneficial effect.) Thus Breadner has illustrated two ways in which the interface between computer science and another subject matter area might be constructed. The "Consumer Credit Program" would be a good vehicle for a computer science teacher to use, and the survey program would be preferable for a teacher from another area, since in both cases the amount of work required of cooperating teachers would be less than that required of the teacher suggesting the venture.

Stewart Cole's "Nutrition Program" offers sufficient possibilities for use in the school outside of classes that a computer science teacher might well assign the project and make the program available for general use without attempting to recruit other teachers. For example, the program could be used to analyze the school lunches. This could lead to other projects when other teachers were informed that the program which did the analysis was an example of the kind of programs that they might become involved in producing.

The problem on the syllabification of words by Barbara Bernstein offers an excellent example of the open-ended exercise. In this case there is considerable programming to be done when the exercise is initially assigned, but in later years (or the first year if the teacher uses the Bernstein programs as a base) students can very easily try out strategies in the already existing framework. The problem probably will never be solved entirely, and any strategies that improve machine hyphenation will be welcomed. The extent of the write-up also indicates the considerable work that can be required in order to generate small programming changes; this again has implications for interdisciplinary projects.

The exercise by Wells, Ciancone, and Near on selecting a team for the "Reach for the Top" competition is also open-ended. ("Reach for the Top" is a television quiz involving teams from high schools across Canada. Some questions are put to the team; others are put to individual members.) The authors suggest several variables that should be considered when developing selection strategies, but use of programs like this will probably uncover other variables which were not considered.

The "Vocational Guidance Program" by Breadner, Izatt, and Armstrong is open-ended in at least two ways. It offers possibilities for additional strategies, as in the previous two programs, but also contains an open-ended data base. These developments can be done in parallel, with new data (vocational categories or data within categories) being added that may be independent of new strategies.

The next two exercises, "Rocket Launch" by Pelliccione, Wilson, and Bernstein and "A Programming Problem in the Area of Aerobics" by Bernstein and Johnson, serve to mark widely separated spots on the dimension of discipline specificity. The rocket launch is tied strongly to physics, although there would be some general interest in the associated display programs. The aerobics program would have general interest; it might never be a part of a regular course, but it would have application in extracurricular fitness programs.

The "Selection of Optimum Location for Bus Stop" is similar to the selection of the "Reach for the Top" team and, indeed, is written by the same three authors. This exercise is a bit more difficult, not only in programming the coordinate comparisons but also in the listing of all the variables that might be used in making an optimum selection.

Finally, "Titration Simulation" by Louis Johnson is included not only for its usefulness as an exercise for chemistry students but also for the format of the program listing. Johnson has made an attempt to capture some of the spirit of structured programming by including in his well-commented listings a liberal application of variable indentations.

In summary, these programs are intended as examples of the way in which exercises in computer courses can provide students with learning experiences in a variety of subject areas. It is not assumed that these exercises demonstrate the only ways in which the stated objective might be achieved. Rather the intent of the book is to encourage the reader to see exercises in computer courses as learning vehicles that can be related to any part of the school program.

The book, "PROGRAMMING PROJECTS ACROSS THE CURRICULUM: TEN PROTOTYPE EXERCISES," may be obtained from:
Publication Sales
The OISE
252 Bloor Street West
Toronto, Ontario, Canada M5S 1V6
The price is \$3.75.

RESPONSE SYSTEM WITH VARIABLE PRESCRIPTIONS (RSVP) --
A FACULTY-COMPUTER PARTNERSHIP FOR ENHANCEMENT
OF INDIVIDUALIZED INSTRUCTION

J. Terence Kelly and Karala Anandam
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RSVP is a system of computer programs which constitutes a computer-based instructional management system. The faculty can be as unique as they desire to be in defining the course content and programming RSVP to accomplish individualized instruction. In the final analysis, the people and the programs together set the limits for what can be achieved to reach the individual student.

INTRODUCTION: THE CURRENT SETTING

American higher education is agonizing over fundamental questions of how best to organize the instructional programs. Forces, equally expressive, are pulling colleges and universities in opposite directions. On the one side there is a rising momentum to return to the traditional, to tighten standards, to retreat to the basic college program, to weed out the underachievers, to return to more conventional methods of teaching, and to reestablish the "true" value of letter grades. This movement is further supported by economic pressures to eliminate the frills, and to de-emphasize any institutional peripheral activities not related to the "heart" of the instructional program. In essence, there is a clear movement to push education back into the so-called "main stream".

On the other side is the thrust to move education further and further away from the traditional. The tremendous increase in a multitude of programs loosely labeled non-traditional are finding their way into the higher education scene. The movement is characterized by the availability of external degrees, university without walls, competency based curriculums, experiential and open learning programs. Increasing and diversified population of students desiring college education has been the impetus for this movement. Minority groups, senior citizens, part-time students, etc., are forcing new modes of instruction. These new adventures in learning rely heavily on media resources and other sophisticated forms of technology.

Amidst these emerging trends in higher education, Miami-Dade Community College has developed an instructional management and delivery system which can comfortably accommodate the needs of both trends. At Miami-Dade we are also experiencing the dichotomy in faculty postures noticed in most institutions of higher learning, but find that the development of our computer instructional management system is squarely on target with both movements. The existence of this system at

Miami-Dade is an attempt on our part to maximize learning to enhance an instructional program, to support faculty in record keeping and course management, and to serve the student in a more efficient way for either "closed" on-campus classes or "open" external classes.

Paradoxical as it may sound, the teachers who have worked with this computer-based instructional management system in an open learning setting have reported that they have sharpened their skills as classroom teachers by working through the various curriculum design requirements made explicit by the system. Such testimony speaks for the ease of placement of this system of managed instruction in whichever direction a particular institution of higher learning is moving.

When analyzed more closely, it becomes apparent that a general objective of the faculty and the capacities of computers to make teaching more individualized are consistent. At least the experience at Miami-Dade has indicated this to be true. This implies that not only can faculty and computer-based instructional management systems co-exist, but they can actually enhance a teaching-learning process. This has been demonstrated by research over a number of years at Miami-Dade. Because of these studies and the experience to date, we think it's important to share our story of how we use the computer to maximize instruction, how faculty can become unencumbered with course details, and how they can be more directly influential in the teaching-learning process.

RESPONSE SYSTEM WITH VARIABLE PRESCRIPTIONS

The Response System with Variable Prescriptions, which is popularly known as RSVP, is an example of faculty-computer partnership directed toward individualizing instruction while managing up to 5,000 students in any single course, whether the course is presented on campus, as independent study, or in a remote setting.

Partly prompted by the increasing concern of faculty and administrators of Miami-Dade Community

College to meet the needs of individual students, and partly instigated by the growing frustration of students who feel cheated of individual attention that is due them, the RSVP system was initiated in Miami-Dade Community College in 1972.

Traditional classroom instructional methods can hardly face the challenge. This is not to say that lack of quality is inherent to classroom interaction. On the other hand, constraints due to space, time and personnel cause a continuous drain on the instructors' and administrators' dedication and commitment to provide quality instruction. RSVP is one means of answering a question that constantly plagues educators and is so succinctly expressed by W. C. Brown, National Research Council, Canada: "How can every student be given the opportunity of salutary instructional dialogue characterized by individual attention?" (W. C. Brown, p. 255)

The conceptualization of the RSVP system owes its origin to another system called Teaching Information Processing System - TIPS, whose author is Professor Allen C. Kelley of Duke University. Except for the variation in core-space requirement, program call routines, and a few other unique features, both are basically Computer-Based Instructional Management (CBIM) systems which succeeded the appearance of Computer Assisted Instructional (CAI) systems (Baker, 1971).

Emergence of CAI systems was an outcome of a recurring theme in the American educational arena - individualization of instruction. While the student computer interaction for learning is truly innovative, and many creative programs have been written for CAI systems, the originators grossly underestimated the level of computer-related equipment and computer time necessary for wide-scale implementation of the CAI systems. It is not surprising that the CBIM systems, of which RSVP is one, began to emerge with a sole purpose of providing the faculty a means of managing instructional designs planned to give individual attention. The term "planned" is not without significance. Anytime an instructor resorts to a computer for management, there is a great deal of planning involved.

Functions of RSVP

Individualization of instruction for up to 5,000 students in a course is accomplished by RSVP by virtue of its potential for three functions:

1. It can maintain student records which have provision for nine different types of information;
2. It can print instructional reports with variable prescriptions based on student responses and student characteristics; and
3. It can provide the instructor with test analysis reports and class reports on individual and/or group of students.

By carrying out these functions described above, RSVP offers the following services for the student, the instructor and the administrator respectively.

For the student, RSVP can 1) provide him with

frequent and detailed feedback regarding his progress through tests that are no longer a device to coerce or grade, but are better labeled "surveys" of student achievement and which serve as valuable learning aids; 2) make a diagnosis based on his personal performance and attributes. The student may be assigned special material to re-study, additional problems to solve, a tutorial session or public hearing to attend, and additional films to view etc. And because the learner's needs may differ from those of all others, he may be the only one with the individual assignment given him. This means the student has explicit personalized direction so that he can adjust his efforts and better his chances for success in the attainment of the course objectives.

For the instructor, RSVP means far less time expended in personalizing efforts that otherwise may be too sporadic to be reliable. Instead, computer-based instructional management system can provide the instructor with extensive and frequent insight to student progress and to one's own instructional effectiveness. The system can provide measures of self-evaluation periodically so that instruction can be modified as and when necessary.

Above all, RSVP means instructor satisfaction that each student is being provided with challenging, individually appropriate learning tasks with the behind-the-scenes assistance of the computer. The computer is, indeed, only a machine. Yet it can become the instrument for achieving a far more detailed, variable and individualized prescription for student accomplishment than is attainable amid the time pressures and distractions of many a classroom.

For the administrator, RSVP provides a valuable managerial tool by which both instruction and student achievement may be evaluated and improved. Quizzes and tests can be replaced or complemented by surveys...non-threatening and serving beyond the traditional role of repeating verbatim what has been learned. Instead, each survey item is designed to measure the extent to which a specific concept has been assimilated, on an item by item basis, and to make specific, individualized prescriptions for improvement.

Administration thus obtains a solid basis for upgrading instruction--collectively and singly. Courses or instructional activities have to be tightly constructed, and clearly defined from start to finish. This implies a sound academic rationale has been built into every aspect of course objectives and evaluation. There is probably far more authenticity at upper levels of college management through this approach than any other.

The advantages are mutual to faculty and administration. Student achievement, in the final analysis, determines the success of any institution of higher learning. Student achievement is in direct proportion to the extent that instruction becomes personal and relevant, adapted to the student's learning style and needs. Response System with Variable Prescription, (RSVP) makes this possible!

INSTRUCTIONAL ASPECT OF RSVP

The instructional functions of RSVP are best utilized when the teaching-learning process is conceptualized as taking the form of Instructor-Student dialogues. The framework of these dialogues consists of three stages:

1. Instructor presentation of instructional stimuli of various types to elicit student response in objective response format;
2. Student response to the instructor's questions by choice of response options; and
3. Instructor responses to the choice made by the student.

Over the term, teaching a course does require each of the stages of the dialogue outlined above. In using RSVP it is highly desirable that the stimulus situations provided for student response be planned in advance together with possible options for student response and appropriate instructor prescriptions for student responses. Although it is possible to devise stimulus situations, options for student response, and prescriptions as the term progresses, it can become hectic and finally a race to determine the strength and stamina of the instructor. It can be done! It is, however, profitable and desirable to conceptualize stimuli with prescriptive responses as the course is developed so that the objective response format items may be given to students when the course is started.

Presentation of stimuli (for use with RSVP) may be by nearly any means: lecture, discussion, reading assignment, film, video-tape, audio-tape, field visit, laboratory work, project assignment, etc. -- and the purpose may be either instructional or evaluative. The focus of this discussion is on the instructional aspects of the objective response format used with RSVP. Student responses to the stimuli provided by the instructor are of importance, not only in the case of the correct answer, but also in the case of the choice of an incorrect answer or in some instances, where there is no correct answer for student choice.

In constructing the multiple-choice items for eliciting student responses, there need to be clearly identified purposes for presenting the stimulus situation. Some of the purposes that lend themselves for meaningful instructional dialogues can be:

1. To identify the gaps in acquired information...gaps may be in the form of "uninformed" and/or "misinformed" condition.
2. To check if students comprehend what they see, hear and read.
3. To identify the difficulties a student may be experiencing while participating in the learning activities...difficulties may be inherent to learning and/or external to learning.
4. To elicit the kinds of questions and/or doubts that a student may raise while participating in the learning activities.
5. To elicit students' opinions, interests, reactions, endorsements, objections, etc., to what is being presented to them through

learning activities.

6. To challenge students' thinking with problem solving situations which are an extension of what has been presented.
7. To encourage students to see several pieces of information in an inter-related context.

Once the purpose is clear, questions can be developed in different ways, to follow or precede or occur during the learning activities such as reading, film viewing, class discussion, etc. As the options for student response are selected for an item, prescriptions for that item should be thought out. Interestingly enough, when an instructor attempts to prescribe, the flaws in the item and options for student responses become apparent. When nothing more than "your answer is wrong, look up page n, in your text" can be said by way of prescribing, one cannot but re-examine the question written in the first place. This awareness is what we referred to earlier as instructors (who have used RSVP for instruction) reporting that RSVP has helped them to become better teachers.

Methods of prescribing can take many forms: prescription for each option, prescription for each item, prescription for a group of items, prescription in relation to attainment of course objectives, prescription by present and past performance, prescription according to student attributes and interests, prescription in terms of student time schedule, location and on and on. Enumerating can become endless. It is done only to point out the possibilities. These forms are not mutually exclusive. Several forms can be used in conjunction. The crucial question is: What criteria should be selected to provide variable prescriptions to meet the individual needs of students? What better opportunity can an instructor ask for to express one's creativity and ingenuity to make teaching unique!

MANAGERIAL ASPECT OF RSVP

In addition to instructional benefits to students when prescriptive teaching is implemented through a system such as RSVP, other benefits accrue for the instructor. These benefits can be examined in the areas of course management and evaluation and research, to which we will turn in the text below.

Course Management

Course management benefits of RSVP are based on the assumption that when stimuli and prescriptions have been prepared for established course objectives, the instructor need exert only a minimal amount of effort to extend these preparations to a larger number of students at any one time, or fewer number of students over repeated times. This does not mean, however, that RSVP implementation for 500 students is as easy as for 50, but it does suggest that effort needed for the additional 450 students is not multiplicative.

Similarly, in an instance where a course may be expected to enroll several hundred students, one instructor might be able to provide the required

instructional leadership using RSVP whereas it would not be possible for a single instructor without such assistance — even for a one-time course offering.

The management function served by RSVP, which can allow such a parsimonious use of resources is that of record keeping. RSVP can maintain and produce the equivalent of a grade book entry for each student, provided its management functions are adequately used by the instructor.

Students' attributes may be stored in RSVP's record system but data need to be input by the instructor; scores on grouped items within a survey or test and grouped surveys or tests are stored in the system only if the instructor previously defined the grouped items and grouped surveys; information regarding which students received what messages from the instructor can be stored in the RSVP system, but the instructor needs to specify that such information be stored. About the only information that is planned for automatic storing is the score and individual item response on a survey or test. Even in this instance, the answer key needs to be supplied by the instructor. The message we are laboring to impress upon you is that the instructor should predetermine which pieces of information are meaningful for a particular program and should plan for their inclusion in RSVP record keeping. Once the plan is communicated to RSVP, records are maintained accurately, whether there are 50, 500 or 5000 students. And in addition, the records are available to the instructor anytime they are desired.

From the perspective of faculty evaluation, it allows an academic administrator and the faculty to have access to definitive and objective data about the direction and the degree of success relative to a particular learning activity as well as an entire course. The system provides information about the process by which the product was achieved. Obviously, not a total answer to all the problems associated with faculty evaluation but a monitoring of faculty work through this system can go a long way in alleviating much of the guess work and subjectivity that is typically at play in faculty evaluation.

Evaluation and Research

One of the functions of RSVP as outlined earlier is to maintain a data record on each student in a course. Utilization of the data for instructional purposes is the prime goal in recording this information by using RSVP. However, the information stored in RSVP on students, their performances and instructors' actions become valuable data source for evaluation and research.

The information can be extracted from the RSVP system through one of its programs (RSVP 08) in a form (cards, tape or disk) which can be used as input to many types of analysis for research and evaluation purposes.

In research conducted at Miami-Dade Community College covering several courses and spanning many terms, it was repeatedly found that students

who use RSVP have a markedly higher retention rate and in terms of grade achievement, perform inordinately higher than those students who do not choose to use the system. (We have used it as an optional service to students in the Open College program.) The student evaluation of this system has consistently pointed out, term after term, year after year, that RSVP rates as the single most useful component of all in the open learning system.

In addition to the availability of data for research, an instructor can evaluate his tests and test items by using the built-in RSVP program (RSVP 07) for test and item analysis which provides question reliability, item difficulty along with means, standard deviations, and frequency distribution of the test scores.

CONCLUSION

RSVP is a tool, nothing less and nothing more. Human minds conceive, create and invent tools. It is again the human minds who evaluate, adopt and creatively use the tools. In the hands of an imaginative and skillful craftsman, a tool can not only accomplish what it is intended for, but go beyond intentions and discover creative, meaningful variations that might sometimes surprise even the originator. We see these possibilities for RSVP.

REFERENCES

- Frank B. Baker, "Computer-Based Instructional Management Systems: A First Book", Review of Educational Research, Vol. 41, Feb. 1971, pp. 56-70.
- W. C. Brown, "Computer-Aided Learning for All", Programmed Learning and Educational Technology, Vol. 12, Sept. 1977, pp. 255-264.
- Allen C. Kelley, "An Experiment with TIPS: A Computer-Aided Instructional System for Undergraduate Education", The American Economic Review, Vol. 58, May 1968, pp. 446-457.

SENTENCE GENERATOR

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In 1964, to describe the English finite verb, Martin Joos put forward a binary schema, upon which Sentence Generator, a CAI program written in BASIC, is based. The numeric input choices by a student user involving 6 pronouns, 6 verbs, and 6 nouns generate short sentences, reflecting subject-verb-object concord, tense, assertion, phase, aspect, voice, and function. Construction 3 takes the form of "...is questioned...", construction 33, "...will question..." In each attempt, the user will direct the writing of just one of 16,128 possible sentences or sentence-like constructions for each lexical verb chosen.

Sentence Generator, an interactive program written in Dartmouth BASIC, demonstrates the extensive array of syntactical forms that a meaning-carrying verb, along with modals and auxiliaries, may take. As written the program might be used as a demonstration model with advanced-students in junior or senior high classes. Key portions of Sentence Generator, with various modifications, can support a number of instructional applications.

408414 12 JAN 67 15:00

W1: I WANT TO SHOW YOU SOME OF THE MANY WAYS VERBS MAY
BE USED IN SENTENCES.

1. I. PRINT A TABLE OF PRONOUNS, VERBS, AND NOUNS, AND
ASK YOU TO MAKE YOUR SELECTIONS. THEN I'LL ASK YOU TO
CHOOSE A MYSTERY CONJUGATION NUMBER.

IN STEP, TYPE "N" WHEN I ASK YOU TO SELECT A PRONOUN.

PRONOUNS	VERBS	NOUNS
1. I	1. AID	1. LIBRARIAN
2. WE	2. ANGER	2. WALL GUARD
3. YOU	3. AVOID	3. TEACHER
4. THEY	4. QUESTION	4. FRIEND
5. HE	5. FIND	5. CLIMATE
6. SHE	6. ANSWER	6. VISITOR

1. SELECT A PRONOUN (TYPE IN ITS NUMBER) 5
SELECT A VERB 2
SELECT A NOUN 1
IS THE WORD TO BE SINGULARLY OR PLURALLY (2) 1
TYPE ANY MYSTERY CONJUGATION NUMBER 0-2237 5

SHE IS ANSWERING HER TEACHER.

2. SELECT A PRONOUN (TYPE IN ITS NUMBER) 3
SELECT A VERB 1
SELECT A NOUN 4
DO THE WORD TO BE SINGULARLY OR PLURALLY (2) 2
TYPE ANY MYSTERY CONJUGATION NUMBER 0-2237 17

WE AIDED OUR FRIENDS.
END (1. THIS IS A SECOND FORM;
OR DID AID OUR FRIENDS.

1. SELECT A PRONOUN (TYPE IN ITS NUMBER) 4

THAT WILL

1.000 SEC. OR 1.00
READY

In 1964 Martin Joos put forward a binary schema to describe English finite verb forms, the schema replacing the traditional paradigm. Joos' schema provides the major underpinnings upon which SG was programmed. In his analysis, the grammatical categories a finite verb exhibits are of an either-or nature:

Category	Either	Or
Tense:	Actual	Remote
Phase:	Current	Perfect
Aspect:	Generic	Temporary
Voice:	Neutral	Passive
Function:	Propredicate	Verb
Assertion:	Factual	Relative

The either column represents unmarked features, the or column, marked ones. Joos gives the marked features decimal values, Remote being 16, Perfect 8, Temporary 4, Passive 2, and Verb 1. Relative assertions is marked by the modals, which are assigned these values:

will....32	must.....160
shall...64	ought to...176
can....96	dare.....192
may....128	need.....208

For those of us brought up on traditional grammatical analyses, trauma is now appropriate. But if we may suspend our emotions, let's continue, gingerly.

- I walk swiftly.
- I was walking swiftly.

The predicates may be analyzed in this manner:

Categories	Sentence a	Sentence b
Tense:	Actual 0	Remote 16
Phase:	Current 0	Current 0
Aspect:	Generic 0	Temporary 4
Voice:	Neutral 0	Neutral 0
Function:	Verb 1	Verb 1
Assertion:	Factual 0	Factual 0
Total Decimal value:	1	21

Taking the analyses on faith, as it were, the point is that each finite verb construction develops a unique number, whether binary or decimal. Overall finite verb constructions are accounted for by the decimal numbers 0 through 223.

Any one of these numbers selected by a user of SG proceeds through a group of tests to set a series of codes that represent the six grammatical categories. SG converting the decimal selection into a set of six binary codes. The user's decimal input is first analyzed to determine whether it is even or odd. If even, then function is coded as propredicate; if odd, function is coded as verb. Five other tests complete the category analyses.

Four of these tests involve double loops. Each category has its own arithmetic progression through the numbers 0-223. Passive voice is involved in constructions 2 & 3; 6 & 7; 10 & 11; neutral voice, 0 & 1; 4 & 5; 8 & 9; 12 & 13.... Thus a loop test that assigns appropriate codes to alternating pairs defines voice. Aspect is defined by a loop test of alternating groups of fours; phase, alternating groups of eights; and tense, alternating groups of sixteens. Modal codes are assigned somewhat differently, by a series of "if less than" tests.

In other formats designed for similar instructional purposes, the category codes could be directly set, bypassing the extensive arithmetic interpretation made by SG. But because SG is a demonstration model designed to confront students with an introductory game approach to the verb, this long deciphering process is employed.

SG goes beyond writing verb phrases. It attempts to write sentences. Thus subject-verb agreement must be accommodated. In the instance of construction 5, SG must choose the correct form of be to match the pronoun selected by the user:

I am questioning....
He is questioning....
They are questioning....

In construction 11, SG must choose the correct form of have to match the noun selected, since this is a passive construction in which the pronoun moves to the agent position behind by and the noun, either singular or plural, becomes the subject.

My teacher has been questioned by me.
My teachers have been questioned by me.

At the beginning of the session these pronoun choices are presented: I, we, you, they, he, and she. Since the pronouns group into a modest pattern, they too are coded for easier SG manipulation. These numeric codes are assigned by SG:

1	2	3
I (me)	we (us)	he (him)
	you (you)	she (her)
	they (them)	

After choosing one of the six nouns, the user declares it either singular or plural. SG then assigns a singular noun code 3, a plural noun, code 2. These codes are later used, in conjunction with various be, have, and suffix decisions, to establish subject-verb agreement.

Nouns are usually signalled by determiners, as a, an, the, this, that. ... In SG the possessive forms of the selected pronouns are used as noun determiners.

I questioned my teacher.
Our teacher was questioned by us.

These arbitrary determiners are transparently assigned.

Only transitive verbs -- those taking objects -- may demonstrate the full range of verb categories, since marked passive voice is denied the intransitives. SG's lexicon includes only transitive verbs. Initially SG had six regular transitive verbs whose suffix features appear alike in print:

Aid	s	ed	ing
Anger	s	ed	ing
Avoid	s	ed	ing
Question	s	ed	ing
Pick	s	ed	ing
Answer	s	ed	ing

By remaining with one consistent visual pattern, SG can direct rather simple suffix concatenation, avoiding spelling subprograms or extensive data arrays. But for the broadest demonstration purposes, it seems that irregular verbs should also be included, since they show differences among forms not expressed by regular verbs. SG was then modified to

include three irregular verbs, which displaced three of the regular verbs:

choose	chose	chosen
see	saw	seen
meet	met	met

These forms are set in data statements, while only the simple forms of the three regular verbs appear in data statements, their suffixes being concatenated within the program.

A skeletal outline of the program follows:

Input and Coding	No. of Lines
1. Message to the User	20
2. User Input	12
3. Initialization at 0 of Verb Attributes	10
4. Evaluation of Pronoun and Noun Input	10
5. Evaluation of Conjugation Input	60
Decisions and Prints	
6. Decisions and Print of Subject	15
7. Decisions on Verb's Suffix	36
8. Decisions on Constructions 0 and 16	8
9. Decisions (and Print) on Modals	1
10. Decisions (and Print) on Have	35
11. Decisions (and Print) on Be	36
12. Print of Verb	6
13. Print of Object (or Agent)	6
14. Data	10

All but two of the odd conjugation inputs proceed once through the program to produce a sentence. Inputs 1 and 17, after producing one sentence, then loop back to outline number 6 to produce a second. Even number inputs also loop the program from number 6 two or three times, the first time making an attempt to develop an artificial context, the second to produce the construction called for, and in some instances the third to produce a British form normally not found in American English.

Within the main section of SG the decision tests are elaborate. It could be that SG's programmer failed to apply sophisticated steps, creating unnecessary complications. Without doubt, though, the major complexities are those emanating from the comprehensiveness of Joos' schema, amplified by the schema's interaction with subjects and objects to generate sentences, or sentence-like constructions. The English finite verb and its subject trigger complex decisions, intuitively imbedded in our minds and

speech, but dramatically exposed in a program.

Utterances and sentences exist in context. Providing appropriate contexts for machine generated sentences proves a challenge, perhaps an impossible task. And this leads to a significant limitation of SG. With the student user in mind, librarian, teacher, classmate, hall guard, friend, and visitor were chosen to establish a school context, as it were. These nouns restrict the lexicon of transitive verbs available to the subject-verb-object sentence pattern that transforms to the passive subject-verb-agent pattern. Additionally, if a consistent visual spelling pattern (s, ed, ing) is sought, the restraints on the available verb lexicon tighten. For student instructional purposes, a prefatory prose piece might improve the context of the sentences generated. But these constraints on context are relatively minor.

A devastating context problem arises with SG's attempt to handle the propredicates, or elliptical verb constructions. Rather simplistically, a propredicate might be considered a form that follows a query, its context and antecedents.

Verb	Propredicate
Can he see his teacher?	He can.
Is he meeting his teacher?	He is.

Such a cryptic summary does violence to the propredicate's grammar, but our concern here is with the impact on SG's output. In runs of SG with he as the pronoun, see as the verb, and teacher as the noun, the following might be produced, the conjugation numbers appearing on the left:

2. His teacher is.
4. He is.
6. His teacher is.

Might a student be confused were he to begin with these conjugation numbers? He might well be. Expressing the assumed missing elements within parentheses might help:

2. His teacher is. (seen by him)
4. He is. (seeing his teacher)
6. His teacher is. (being seen by him)

But this does not present a context. SG, when it encounters a propredicate construction, produces a complete question preceded by a note and followed by the propredicate structure.

In response to: Is his teacher seen by him?

2. She is.

In response to: Is he seeing his teacher?

4. He is.

In response to: Is his teacher being seen by him?

5. She is.

These few examples, obviously carefully chosen, would appear to suggest a partially satisfactory resolution. However, in most instances, within the complete range of forms, particularly the vast numbers involving modals, it falls into serious decay. Such a limited, contrived context just won't do the job. This is to say, then, that SG falls short of accomplishing what it purports to do. Ambivalently, we might rejoice in being reminded that English is of man, not of machine, and that we have another barrier to assault, as best we can.

Besides context difficulties other limitations bear noting. The complete array of constructions that SG generates includes a group phonetically not acceptable to most speakers of English, a group composed of be-being and been-being combinations, as these:

18. He has been being questioned by his teacher.
19. He will be being questioned by his teacher.

Joos' schema anticipates these and provides for them. Indeed Joos cites two cases he found in non-published prose. However, finding such forms in edited prose is highly unlikely. This writer has on infrequent occasions heard some of these forms in the speech of well-educated speakers, usually in informal, animated conversation. When one of these forms is generated by SG, a note is presented to the user before the sentence or sentence-like construction is given.

Excluding the be-being and been-being forms, there are a number of other issues that SG fails to cope with adequately. Appropriate comments on these would begin to lead us into the depths of the study and work of the English teacher. Yet since SG rather flagrantly demonstrates these to the caustic eye of the grammarian, it is proper to allude to their presence.

Essentially, these deficiencies of SG are posed because it attempts to put into action a comprehensive demonstration of Joos' complete schema. However, with the work of the classroom English teacher in mind, SG can be edited in a manner to support some fundamental needs of instruction. In the process, the major limitations cited and alluded to will disappear. First, an adapted pro-

gram can generate just complete sentences, thereby sweeping away the pro-predicates and their context problems. Second, be-being and been-being forms can easily be blocked off and denied. Third, the modals can be arbitrarily reduced, if need be. In effect programs can be modeled to generate only those constructions that approximate the most used verb frequencies of prose. These changes would dramatically reduce the size and complexities of the programs.

By narrowing objectives -- that is, by identifying specific instructional goals, as for example, well-known pronoun and verb usage problems that many students face -- some of the generative powers of programs modeled in manners similar to SG should prove advantageous.

SIMPLIFIED CAI/CMI APPLICATIONS IN GENERAL EDUCATION AT MCCC

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This presentation includes: A. a description of MCCC's instructional computing configuration; B. timesharing in non-math/science areas; C. experimentation: "canned" programs vs. local programming; D. development of a transparent user group; E. CAI/CMI: an on-line demonstration; F. status of MCCC simplified instructional computing; G. local projections; and H. implications for other schools.

A. A Description of MCCC's Instructional Computing Configuration:

Macomb is the largest community college in Michigan and the fifth largest college in the state (approximately 25,000 students). The need for expanded instructional computing became apparent ten years ago when MCCC had gradually developed a dependency upon leased instructional computer services. Recently the college purchased an HIS (Honeywell) 6023 computer and an extensive configuration of related hardware and peripherals. Now the college has, through GCOS and EDINET software, consortium arrangements with the University of Michigan, and local user group expertise, a wealth of available resources to provide ample instructional computing in the major languages (BASIC, FORTRAN, COBOL, etc.) for all academic and specialty areas. However, heavy use has already strained existing capacity and will force MCCC to upgrade in the near future.

B. Timesharing in Non-Math/Science Areas:

Traditional instructional computing users usually have clear, well defined ways of accessing available timesharing systems; CAI and other applications are increasingly commonplace in math/science curriculum, and their use is often encouraged in progressive teacher training programs. But in most general education areas (such as English, humanities, art, etc.) little (if any) thought or planning has occurred to encourage potential use in higher education. Even so, preliminary results in these and other areas appear promising and reflect a trend toward heavy computer use by previously inexperienced educators.

At MCCC general education users have developed CAI/CMI programs in simulation,

drill and practice, test scoring and analysis, and instructional DBMS (data base management systems). Also there are some miscellaneous applications which do not fit into these categories. Some programs have been developed by vendors or other colleges, and some were written by MCCC instructors. Regardless of the source of this activity, an increasing number of instructors are using the computer with positive results. And it is projected that this growth of general education use will continue for some time.

C. Experimentation: "Canned" Programs vs. Local Programming:

Much of the local effort in general education has been directed toward converting existing programs from vendors and other schools to run on MCCC's HIS system. There have been some difficulties encountered adapting and using these programs, but most problems have been overcome through an effective liaison established between the faculty and data processing personnel. Thus there is now a highly diversified base of instructional programs in heavy use at both campuses.

The most difficult problem, not yet completely solved, is writing appropriate programs for local curriculum in general education. Statistics are of some use, but many non-traditional users are unfamiliar with data analysis and statistical theory. Further, their expertise in programming is quite shallow. So it has become necessary to introduce simplified programming parameters to interested teachers who have no computer experience. Text Editor (HIS BASIC subroutine) has provided that vehicle on a most flexible, transparent basis. Demonstrations have been held since December, 1975, and to

date many faculty and other college staff have become proficient users of Text Editor. The first session lasts about one hour. Then the maximum training time consists of two question-and-answer seminars (90 minutes each), 10 hours of outside study, and 2 hours of hands-on practice. But some personnel have learned the system much sooner (minimum time: 5 hours). Thus it has been concluded that experimental programming in general education will continue, but only in direct proportion to the development of user expertise.

D. Development of a Transparent User Group:

While in the process of selecting a new computer, MCCC's data processing committee visited several schools throughout the country. One observation made, true at all schools visited, was that user groups were most effective when the members controlled the resources allotted by the school management for instructional computing. Also it was noted that the most successful groups trained new members and encouraged people from all employee groups to join. So, based on this information, MCCC decided to form its user group in a similar way. The traditional areas were represented: math/science, business, numerical control technology, etc.; and other individuals were also encouraged to participate in forming the user group: faculty from English, art, humanities, social science, speech, and counseling, and a variety of non-instructional personnel.

In addition, these groups were involved in college-wide decision making at the district level with advisory power to the president and the board of trustees. Thus a significant voice in data processing affairs relating to instruction has been given to the faculty and to other functional areas of the college. And this input has enhanced management's ability to understand the needs and problems of the entire college, thereby increasing the effectiveness of data processing resource forecasting and distribution.

Another outcome of this wide representation on the user group has been the dynamic effect on the various users. Before its formation the various disciplines and non-instructional areas were virtually isolated from one another. And while this isolation to some degree still exists, the user group has stimulated dialog, problem-solving, curriculum development (computer and non-computer related), and sharing of ideas on a broad scale. In short, it has become a welcome addition to the college's institutional structure in the viewpoint of administrators, faculty, and other non-instructional personnel.

E. CAI/CMI: An On-Line Demonstration:

A TI-743 briefcase terminal will be used to show the status of CMI English development and the various programs and files now in use. Simulation could be repeated to demonstrate the depth of MCCC's time-sharing library. But with the exception of several programs from the University of Michigan and several converted vendor programs, MCCC's library is essentially limited to EDINET programs and files. Those interested in a more in-depth review should contact either Honeywell or Dr. Robin D. Avery at MCCC.

This presentation will be limited to general education applications from English (Text Editor, CMI) and Art (FORTRAN - Explorer subroutine, CAI). The English material will be presented on-line; the Art material can be shown on-line if a Decwriter terminal or similar device is available. Otherwise, preprinted samples will be distributed during the presentation. Other areas have developed many additional programs, but appropriate demonstration models could not be prepared in time for this presentation.

F. Status of MCCC Simplified Instructional Computing:

Faculty, counsellors, management, and a variety of non-instructional personnel are now using MCCC's computer to deal with situations that used to be confronted manually (or not at all). In instructional areas programs have been developed for test scoring and analysis (with optional direct instructor involvement), simulation (heavy use in social science and business) drill and practice for tool skills in some areas, computer art, and CAI/CMI in English and general science. These programs have been developed within the last five years and are most encouraging, especially considering the addition of the Text Editor subroutine to the timesharing system. However, the same constraint exists for growth of instructional computing as for experimental programming: the extent of development of both will be dependent upon the degree of user expertise.

G. Local Projections:

MCCC has developed a cooperative relationship with junior high schools, high schools, and colleges in Michigan regarding the development and sharing of instructional data processing programs and other information. No consortium has yet been established, but the trend is in that direction. Also industry has shown a sincere interest in the college's various programs because many students eventually are employed by these firms, especially those which require a proficiency in data processing skills. Therefore, it is pro-

jected that such relationships will continue and will become more intense: cooperative sharing within the institution, productive interaction with other schools at all levels, and continuing contacts with prospective employers of MCCC's students. And assuming that these projections are accurate, it is incumbent upon the college to provide, evaluate and refine instructional data processing curriculum and related resources to the highest level possible.

H. Implications for other Schools:

MCCC's experience in developing a multi-level data processing environment may be of value to other schools planning similar ventures. First, careful planning should be done to encourage wide participation in the formation and development of the instructional-user group. Second, consideration should be given to simplification of access to the system for the benefit of the inexperienced user. (This may be quite difficult if resistance to computer influence is strong.) Third, management and instruction should cooperate as much as possible in the acquisition, allocation, and evaluation of instructional data processing resources. Fourth, cooperative relationships should be established and maintained outside the school environment for the sharing of resources, especially with nearby schools and prospective employers. Finally, projections for system upgrading should be made before a current upgrade has been completed.

References:

Avery, Robin D. "A Simplified Systems Approach for Humanistic Education." AEDS, 1973.

Honeywell Information Systems, Inc. Time Sharing: Text Editor. DD18, 1975.

Katzan, Harry Jr. Computer Data Management and Data Base Technology. Van Nostrand Reinhold, 1975.

Macomb County Community College. Computer Selection Study. MCCC, 1974.

Sundgren, Bo. Theory of Data Bases. Petrocelli/Charter, 1975.

TEACHING ENGLISH GRAMMAR USING A MICROCOMPUTER

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Grammars of natural languages may be represented as procedures and simulated on a computer. Computer programs can be developed which model aspects of English syntax and semantics. This paper describes a set of procedures implemented on a microcomputer designed for teaching and research in natural language analysis.

As the availability of computing resources has increased, the trend of using computers in a variety of educational environments has also been established. This paper deals with the use of computer aided studies in English grammar. Specifically, I describe the use of a set of computer programs for simulating the process of grammatical analysis of English sentences. Particular attention is given to implementation of grammar testing programs on a microcomputer system.

Studies in natural languages, like English, indicate that the primary function of a grammar is to produce an interpretation of a well formed string of words. The grammar specifies an ordered set of rules for assigning an interpretation to the input string. Scientific studies of language involve exploration of various models for describing the processes native speakers use in written or oral communication. The computer may serve as an aide in language studies by playing a role similar to the one it plays in mathematics and the hard sciences. The consequences of particular models are simulated on computer, providing a tool for research and education. Simulation of language processing requires writing a grammar in procedural form.¹

The analysis of a natural language sentence requires a rather small set of functions which are then combined in a procedure. Consider first the simple problem of syntactic recognition of a simple sentence: 'The computer digested the program.' A procedure can be written to proceed left to right in the sentence selecting one word at a time and to check its syntactic word class in a dictionary. A function CAT is defined which carries out this process. From studies in grammar we know that the sentence may be modeled by the rule $S = NP + VP$ with $NP = DET + NOUN$ and $VP = VERB + NP$. The phrase rules may be treated as subprocedures and called recursively.

Simple phrase rule grammars of the type given above are not powerful enough for natural lan-

guage.² Two functions must be developed in order to store information about the context and lexical features of words. One function, SETR, when called, sets a register in memory which is used to store information about a sentence as it is processed. Another function, GETR, is used to retrieve information about previously processed portions of the sentence. Once a phrase or sentence is completed the function BUILDS is used to build a structure from register contents. Using these functions, context sensitive aspects of language can be treated through building temporary interpretations of natural language input. Thus as more information is gathered through the processing of the language data, unambiguous interpretations of the language input can be obtained.

An example of simple grammar for English in terms of these functions is given below. This grammar is operational on a SNOBOL4 based system called SNOPAR.³

S	PARSE(NP())	:S(TO(.SNP))
	CAT('AUX')	:S(TO(.QUES))
		F(FRETURN)
SNP	SETR(.S,'TYPE','DCL')	
	SETR(.S,'SUBJ',Q)	
TRYVP	PARSE(VP())	:S(TO(.POPS))
		F(FRETURN)
QUES	SETR(.S,'TYPE','QUESTION')	
	SETR(.S,'AMX',Q)	
	SETR(.S,'TENSE',GETF('TNS'))	
	PARSE(NP())	:S(TO(.QNP))
		F(FRETURN)
QNP	SETR(.S,'SUBJ',Q)	:S(TO(.TRYVP))
POPS	SETR(.S,'PRED',Q)	
	S=BUILDS(S)	: (RETURN)
NP	CAT('DET')	:S(TO(.DET))
	CAT('PRO')	:S(TO(.PRO))
	CAT('NPR')	:S(TO(.NPR))
		F(FRETURN)
NPR	SETR(.NP,'PROP',Q)	:S(TO(.POPNP))
PRO	SETR(.NP,'PRO',Q)	:S(TO(.POPNP))
DET	SETR(.NP,'DET',Q)	
ADJ	CAT('ADJ')	:F(TO(.TRYN))

```

TRYN   SETR(.NP,'ADJ',Q)      : (TO(.ADJ))
        CAT('N')             : F(FRETURN)
        SETR(.NP,'N',Q)
TRYPP  PARSE(P())             : F( TO(.POPNP))
        SETR(.NP,'PP',Q)      : (TO(.TRYPP))
POPN   NP=BUILDS(NP)          : (RETURN)
PP     CAT('PREP')           : F(FRETURN)
        SETR(.PP,'PREP',Q)
        PARSE(P())           : F(FRETURN)
        SETR(.PP,'PREPNP',Q)
        PP=BUILDS(PP)         : (RETURN)
VP     CAT('V')              : F(FRETURN)
        SETR(.VP,'V',Q)
        PARSE(P())           : S( TO(.VNP))
TRYVPP PARSE(P())             : F( TO(.POPVP))
        SETR(.VP,'PP',Q)      : TO(.TRYVPP)
VNP    SETR(.VP,'NP',Q)      : TO(.POPVP)
POVPV  VP=BUILDS(VP)         : (RETURN)

```

The PARSE function transfers control to the sub-procedure given in the parentheses. For example, PARSE(NP()) transfers control to the statement labeled NP. At each level (i.e. S or NP) a register list is built and stored under that level name. This list is used in the BUILDS function to construct a tree structure.

Grammars of the type given above have been developed for the SNOFAR system and may be used for teaching aspects of natural language syntax and semantics. SNOFAR is also being used as a research tool for testing model grammars in several languages. A fairly powerful grammar of English has been developed which can handle embedded sentences, possessive pronouns, and a variety of other grammatical features. An example sentence which can be handled by the more powerful grammar is: 'I think that I saw her with you'. The resulting structure produced by the parsing is:

```

(S(TYPE DCL)(SUBJ (NP(PRO I))) (PRED (VP(TNS PRES)
(VT THINK)
(OBJ (NP(COMP (S(TYPE DCL) SUBJ (NP(PRO I)))
(PRED (VP(TNS PAST)
(VT SAW)(OBJ (NP(PRO YOU)))(PREP WITH(NP(PRO
HER)))))))))))))

```

One of the problems with the use of grammar testing in an educational environment is the cost of computer time. As a result of the problem of cost and accessibility to large computer systems, work has begun to develop a simple grammar parser (MICROPARSER) for a microcomputer system. Each of the functions CAT, SETR, GETR, and BUILDS along with a dictionary management program MAKELEX were modeled as PLM procedures. These procedures were then compiled in terms of INTEL 8080 code and implemented on an MDS system. The system can operate in 8k of memory and will do simple parsing of English sentences. An example interaction with MICROPARSER is given below:

```

JOHN BROKE THE DISH.
(NP
(NPR JOHN)
(NP
(DET THE
(N DISH)
(S
(TYPE DCL )
(SUBJ
(NP

```

```

(NPR JOHN))
(VP
(V BROKE)
(OBJ
(NP
(DET THE)
(N DISH) )

```

All parsed structures are stored as tree structures in memory.

Writing grammars for MICROPARSER requires using a different format than the one used for SNOFAR. The following procedure for a prepositional phrase is shown to illustrate the form of the MICROPARSER grammar:

```

PP: PROCEDURE BYTE;
IF CAT(PREP) THEN DO;
    CALL SETR(.PP,'PREP','*');
    IF NOUNP THEN DO;
        CALL SETR(.PPI,'NP1','*');
        CALL BUILD(.BUILD9);
        RETURN 1;
    END;
    ELSE RETURN 0;
END;
ELSE RETURN 0;
END PP;

```

While there is considerable amount of development needed before MICROPARSER can function as a complete grammar testing system, it does show the possibility of developing sophisticated applications of computing on small systems. The intended use of MICROPARSER is for demonstration of grammatical functions in a computer based education environment and for linguistics research.

References.

1. Woods, W.A. 1970. Transition Network Grammars for Natural Language Analysis. Comm. ACM, 13, #10, 591-606.
2. Winograd, T. 1972. Understanding Natural Language. New York: Academic Press.
3. Kehler, T.P. 1976. SNOFAR: A Grammar Testing System, A.J.C.L. Microfiche 55.

TEACHING TEACHERS VIA COMPUTER

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The purpose of this paper is to describe how and why the faculty of a larger-scale teacher-preparation program incorporated computer assisted instruction (CAI) into their program. The paper briefly describes the secondary school teacher-preparation program at Illinois State University, explores some of the reasons the faculty decided to incorporate CAI, and describes the kinds of topics and programming formats selected.

Most teacher educators are continually looking for ways to improve their programs. One way that should become increasingly attractive is the incorporation of computer assisted instruction (CAI). What follows is a brief description of a non-traditional teacher-preparation program, the reasons that program is going to greatly increase its use of CAI, and descriptions of the kinds of CAI being incorporated. Other teacher educators who are considering CAI for their programs may find the information useful.

BACKGROUND

In the late 1960's, the Department of Education at Illinois State University began a major revision of its teacher-preparation program. Among the goals of the revision were to enable students to learn at their own rates, to expose students to a wide variety of instructional tools, and to assure that all graduates demonstrated all required competencies.

In 1971, ISU implemented the Professional Sequence, a self-paced, competency-based, teacher-preparation program for prospective secondary school teachers. The Professional Sequence enables about 1500 students per semester to learn at their own rates. It does this by dispensing with traditional classes and relying instead on a series of self-instructional packages which students complete at rates commensurate with their own abilities.

The program exposes students to a variety of instructional tools by building into the packages (which are, themselves, new instructional tools to many students) a variety of learning activities. At one time or another students learn by reading; by viewing films, video-tapes, and tape-slide programs (available on a random-access information retrieval system); by demonstrating teaching skills and video-taping the demonstrations for later analysis; by writing; and by participating in seminars. CAI existed in the program but more on a demonstration basis than as an integral part.

To assure that all graduates demonstrate all competencies, a series of checkpoints has been established. As students move through the program a computerized record is kept of which competencies each student has demonstrated. No student is allowed beyond any checkpoint until he or she has demonstrated all the competencies required up to that point.

Although the Professional Sequence is achieving its major goals and although it has proven to be at least as effective in preparing secondary school teachers as its more traditional counterparts,¹ it is, like most other programs, continually striving to improve itself. One revision planned for the fall semester of 1977 is the incorporation of CAI.

WHY CAI?

There are a number of reasons to

incorporate CAI into teacher-preparation programs and many of these reasons are as applicable to traditional programs as they are to non-traditional programs. Consider the following points.

Reason 1: CAI Can Save Instructional Time

A perusal of the literature will reveal many studies showing that CAI can save instructional time while maintaining or increasing students' achievement levels. One study, for example, "... showed that adults learning computer programming through CAI took from five to 10 hours to reach the same level of proficiency as students who spent from 24 to 30 hours in traditional instruction."² Another study "... compared computer simulation of high school physics experiments with traditional laboratory experiments and found that the CAI students learned more in one eighth the time."³ Numerous other students could be cited but they would verify the same point--students can spend significantly less time learning via CAI and still achieve as well as, or better than, students who learn via traditional methods.

Since most teacher-preparation programs have limited lengths of time during which to prepare students, any instructional tool that can reduce instructional time while still enabling students to maintain or increase their achievement levels should be utilized to the fullest extent. The instructional time saved can be used to increase the number of competencies students develop thereby increasing their desirability as teacher candidates and their effectiveness as teachers.

Reason 2: Teacher Educators Should Demonstrate the Appropriate Use of Instructional Tools

Many teacher-preparation programs rely heavily on classroom activities such as lectures and discussions to teach prospective teachers how to teach. In some instances these group activities are used to provide instruction about ways to individualize and about new instructional tools. It seems logical to assume that a good deal of cognitive dissonance is created in students' minds when they are being taught, via procedure A, about the advantages of procedure B. It could be that this dissonance helped give rise to the adage that "teachers teach as they were taught and not as they were taught to teach."

It may be, in fact, that some topics

on interest to teach educators, such as the components of instructional objectives, the classification of objectives according to taxonomic levels, and certain aspects of measurement and evaluation, can be mastered most easily if students engage in simple drill and practice. Certainly tutorial and drill and practice CAI programs could reduce the amount of time teachers need to spend on basic instruction about these topics and could thus free more time for in-depth analyses of these and other topics.

Much the same may be true with helping students develop their decision-making powers. It is virtually impossible, in a classroom situation, to enable students to make decisions and to provide each student with feedback concerning the consequences of those decisions. Simulation programs can do this and they can do it for numerous students simultaneously.

It seems apparent that if we teacher educators expect graduates of our programs to go into their own classrooms and vary instructional procedures and select appropriate instructional tools then we should provide them with examples of how these things can be done. We should, for example, begin teaching more with CAI as well as more about CAI.

Reason 3: There Is An Increasing Need For Teachers Who Know About, And Who Can Use, Computers

The American Institutes for Research (AIR) funded a study to determine how much growth there was in computer utilization by the nation's secondary schools from 1970 to 1975. The study showed that while about 34 percent of the schools used computers in 1970, "... over 58% of the nation's secondary schools today use a computer to aid their administrative or instructional programs."⁴ The study also projected that if current trends continue, "... within the next decade every secondary school in the country will have access to a computer system for some type of administrative and/or instructional application."⁵

The AIR study pointed out that the most frequent instructional applications of computers were in courses related to computer science, business, and mathematics,⁶ but given the increasing availability of computers and the continual search by teachers for ways to individualize instruction and to help students develop

decision-making powers, it seems realistic to predict a significant increase in the use of CAI.

The fact that increasing numbers of secondary schools are acquiring computer power should be, itself, sufficient warning to teacher educators to begin producing more graduates who can capitalize on the computer's potential. The warning becomes even more clear when one considers that schools are continuing to acquire computer power even now, during some of the most fiscally distressing times they have ever experienced.⁷ It is certain that as administrators struggle to make fewer dollars do more work they will try to employ the most highly qualified and versatile teachers possible. Assuming all other factors are approximately equal, teacher candidates who have had experience with computers as instructional tools and who can help administrators make the best possible use of available computer power will likely have a decided advantage over candidates without this background and skill. The inclusion of CAI in teacher-preparation programs can be a deciding factor in helping candidates acquire teaching positions. It would be unfair to students in a teacher-preparation program to deprive them of this opportunity.

Reason 4: The Use of CAI Can Lead To Other Computer Applications

Introducing students to CAI is a little like giving them just one peanut--it makes them want more. Although students usually approach computers with some trepidation, it does not take long for them to begin enjoying interactive programs and asking to use others. In the Professional Sequence, for example, tutorial and drill and practice programs were field-tested with over 500 students and over 98 percent of those students indicated they liked CAI and wanted to engage in more of it.

The interest students show in interactive CAI carries over into other computer applications, particularly problem-solving and inquiry. Once students overcome their initial hesitation to use computers they seem willing to try a variety of applications. Sequence students use the computer to generate interaction data for Flanders' Interaction Analyses and for ERIC searches as well as for CAI. This kind of familiarity with an instructional tool is exactly what is needed by teachers if they are to use that tool to effectively meet the instruc-

tional needs of their own students.

In addition to finding out how computers can aid instruction, students should also find out how computers are used in scheduling, grade reporting, guidance, long-range planning, inventory control, and bookkeeping. This kind of information can help broaden students' perspectives and give them a more realistic idea of how modern systems are operated. This, in turn, can help students acquire a better understanding of education as a whole and their role within it.

Reason 5: Teacher Educators Should Be Among The Leaders In Developing New Instructional Tools And New Applications Of Instructional Tools

"One of the goals shared by teacher educators is the production of a cadre of professionals who view methodological research as a scholarly activity worthy of their time and effort, and who are responsive to research results which suggest a reevaluation of classroom practices."⁸ Other areas such as the physical and natural sciences, psychology, sociology, and industrial technology, are seizing the initiative. Their work with computers is helping them attract more and more students because students see these areas as fitting into the future. Few students will want to participate in programs which appear provincial and even backward when they could participate in programs which seem to clearly prepare them for the demands of tomorrow. Teacher education programs should be among the most innovative and exciting programs on any college campus.

More to the point, if teacher educators choose to ignore or minimize the potential of computers there is little reason to suppose that prospective teachers will utilize computer power when they get into their own classrooms. This would be unfortunate not only because a tool of demonstrated effectiveness would lay unused, but also because some students who might profit from CAI will be denied that opportunity. No tool that might help students learn should be ignored and no teacher should feel he or she is adequately prepared to teach unless he or she can use a number of different instructional tools--including computers.

There are, of course, other reasons to include CAI in teacher-preparation

programs (such as its cost-effectiveness⁹ and its utility in in-service programs¹⁰), but these reasons simply reinforce the reasons already cited. Logic, as well as the facts cited, support decisions to include CAI as an integral part of teacher preparation programs. Happily, there are a number of topics included in most teacher-preparation programs that lend themselves readily to CAI.

CAI POSSIBILITIES FOR TEACHER-EDUCATION

At the present time CAI in the teacher-preparation program at ISU is focused on five topics--the components of precise instructional objectives, taxonomic divisions of objectives, measurement and evaluation, Flanders' Interaction Analysis, and curriculum development. These topics provide vehicles for the utilization of drill and practice, tutorial, inquiry, simulation, and problem-solving programs, and this variety not only gives students some idea of the flexibility of CAI, but also gives them a fair for beginning to assess the usefulness of CAI as an instructional tool.

The Structure of Precise Instructional Objectives

Under current plans, the first CAI program students will use will deal with the structure of precise instructional objectives. The objective of the program is to enable a student who is given a series of instructional objectives, to pin-point via the computer, the weakness, if any, in at least 80 percent of the objectives.

Students use the program by first inputting their names and then opting to either review the basic components of precise instructional objectives or to bypass the review. The review is presented via a tutorial format and is extensive enough to enable students without previous knowledge of objectives, to be successful in the remainder of the program.

Once students either go through, or bypass, the review they are presented with a series of objectives and a constant set of weaknesses common to objectives such as, 'Observable behavior missing or unclear,' or 'Minimum acceptable standard missing or unclear.' As students pin-point the specific weakness, if any, in each objective they receive corrective

feedback and reinforcement. Following completion of the first series of objectives the program prints out a listing of which objectives were missed and makes an analysis of the overall response pattern.

If students miss more than 20 percent of the items they receive remediation based on their areas of weakness as determined by the analysis of their response patterns. Following the remediation students are presented with a second series of objectives. The cycle of response, feedback, and analysis is repeated for the second set of objectives but if the 80 percent criterion level is not met this time, the student is referred to a second program on objectives (entitled Precise Instructional Objectives) or to a faculty member for further help. Students who achieve the 80 percent criterion level on the first set of objectives have the option of doing the second set or bypassing it.

The program entitled "Precise Instructional Objectives," is similar in format to "The Structure of Precise Instructional Objectives" program and is used for remediation for students having difficulty grasping the concept precise instructional objectives. It takes a slightly different approach but its basic purpose is to provide additional information and practice.

* Both of the above programs are written in BASIC and each takes students about 30 minutes to complete.

The Cognitive Domain

Under current plans, the second CAI program students will use will deal with taxonomic divisions of objectives and particularly with "Bloom's" cognitive domain. The objective of the program is to enable a student who is given a series of instructional objectives, to classify via the computer, at least 80 percent of the objectives according to their appropriate level in "Bloom's" cognitive domain.

The format of this program is the same as the preceding program. Students opt to either receive or to bypass an extensive review section that is presented via a tutorial program. Following this section students are presented, via a modified drill and practice program, with a series of objectives which they classify according to specific levels with the cognitive domain. Feedback and reinforcement

follow each response and an analysis is made of overall response patterns. Remediation and a second set of objectives is provided for those students who did not achieve the 80 percent criterion level on the first set.

This program is also written in BASIC and takes students about 30 minutes to complete.

Measurement and Evaluation

The third program students will use will deal with terms basic to measurement and evaluation. The objective of the program is to enable students to select definitions and/or apply via the computer specific measurement and evaluation terms.

The format of this program is generally similar to the formats of the preceding programs. Students first input their names. The program then prints out a list of 20 terms basic to measurement and evaluation and gives students the option of having any or all the terms defined and explained. After students have as extensive a review as they desire (presented via a modified inquiry format), they are presented with a series of situations in which they must apply or define the terms. Corrective feedback and reinforcement is provided following each response.

After students complete the items they receive an accounting of the items they missed and an analysis of their overall response pattern. They are told, for example, if they were weak in the general area of reliability, validity and overall measurement and evaluation, the general area of kinds of tests, and/or the general area of statistics. Students are also given the option of an additional review in the area(s) they are weak in.

The program is written in BASIC and takes students about 30 minutes to complete.

Flanders' Interaction Analysis

The preceding programs provided students practice in using drill and practice, tutorial, and inquiry formats. This program gives them practice in using a problem-solving format.

At the request of a Professional Sequence faculty member (Dr. Robert Fisher), a problem-solving program was constructed

which enables students to input the ratings they record as they chart verbal interaction in a class and receive a full analysis of those ratings via computer printout.

Since the program frees students from the onerous task of calculating matrices and making various correlations, more students are more willing to use Flanders' Interaction Analysis. Further, availability of the program has prompted the Sequence faculty to build into a number of micro-teaching packages a Flanders' component.

The program is written in FORTRAN and takes students about ten minutes to complete.

Curriculum Development

To date, the most ambitious CAI application in the Professional Sequence is in the area of curriculum development. One Sequence faculty member (Dr. Clifford Edwards) has done a good deal of work in the area of curriculum theory and development and wanted to facilitate students' understanding of a decision-making model he developed and to give them practice in using that model. Dr. Edwards sought assistance in using CAI to achieve his goals and a series of three programs were developed.

In the first program students opt either to receive or to bypass a review of the components of the Edwards' decision-making model. As in the programs dealing with objectives, taxonomies, and measurement and evaluation, the review section in this program is extensive enough to enable students to be successful in the remainder of the program. Continuing in a tutorial format students then "walk through" a hypothetical situation using the model and receiving feedback concerning the interaction of their various enroute decisions.

The second and third programs in the series are two parts of a single simulation program in which students apply the Edwards' decision-making model to a given situation and receive feedback concerning the internal logic and the consequences of their decisions.

These three programs are written in BASIC and currently take students about 40 minutes each to complete. Revisions

are planned in the programming which will reduce completion times to about 30 minutes per program.

CONCLUSION

The CAI programs described in this paper have been field tested and will become, with little or no modification, integral parts of the Professional Sequence--the secondary school, teacher-preparation program at Illinois State University. The decision to integrate CAI into the Professional Sequence was made for a number of reasons including: (1) the demonstrated effectiveness of CAI; (2) the need for teacher educators to demonstrate the appropriate use of instructional tools; (3) the projected demand for teachers able to capitalize on the increasing computer power available to secondary schools; (4) the flexibility of computers as tools useful to teachers, administrators, and support personnel; and (5) the need for teacher educators to demonstrate leadership in the development and application of new instructional tools.

The Professional Sequence chose as topics for its CAI programs the components of precise instructional objectives, taxonomic divisions of objectives, measurement and evaluation, Flanders' Interaction Analysis, and curriculum development. Selection of these topics facilitated the demonstration of a variety of programming formats including drill and practice, inquiry, simulation, and problem-solving. Additional topics and programming formats are under consideration but their development will depend on further evaluation of the existing programs.

It seems reasonable to assume that those teacher educators who are slow to incorporate CAI into their programs will begin experiencing declines in their enrollments as prospective teachers seek out more progressive and up-to-date programs. This would be unfortunate because the move toward CAI is neither difficult nor painful. CAI belongs in today's teacher-preparation programs. Help put it there.

For additional information concerning any of the programs described in this paper contact: Dr. Michael A. Lorber, DeGarmo Hall, ISU, Normal, Ill., 61761.

FOOTNOTES

1. Dennis Gene Wiseman, "A Criterion-Based Comparison of Student Teachers From Two Teacher Education Programs, One Competency-Based And One Conventional," Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign, 1974.
2. Marcella L. Kysilka, "How Effective Is CAI? A Review of the Research," Educational Leadership, November, 1975, pp. 149-150.
3. Ibid. p. 150.
4. William J. Bukoski and Arthur L. Korotkin, "Computing Activities in Secondary Education," Educational Technology, January, 1976, p. 9.
5. Ibid. p. 20.
6. Ibid. p. 9.
7. "Education--Learning to Live With Less," Time, October 4, 1976, pp. 58-63.
8. Gary D. Brooks, "Computer Science: A Neglected Area in Schools of Education," Phi Delta Kappan, October, 1971, p. 121.
9. Judith Edwards et al., "A Triumph For CAI," Phi Delta Kappan, September, 1974, pp. 70-72.
10. Keith A. Hall et al., "A Triumph For CAI," Phi Delta Kappan, September, 1974, pp. 70-72.

USING MOSES TO TRAIN ADMINISTRATORS AND ADMINISTRATION STUDENTS
IN THE UTILIZATION OF COMPUTERIZED DATA BASE MANAGEMENT SYSTEMS

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ABSTRACT: This paper describes a software package - MOSES - which was developed to train practicing school administrators and administration students to design and manage computerized data base information systems. MOSES emulates many of the capabilities of commercially available data base management systems. Its high level interactive characteristics enable individuals with no previous computer experience to learn about such systems by hand-on implementation of a computerized management system of their own design.

INTRODUCTION

MOSES was borne out of a desire to provide practicing administrators and administration students with a simulated experience in establishing and operating a computer based management system and to demonstrate the feasibility and desirability of an interactive data base approach to management systems in education. Traditional approaches to designing information systems have been application oriented with a system consisting of a set of programs, each with its own data sets, developed for each application. Such an approach is adequate in an organization which has a limited number of administrative applications and in which the characteristics of these applications are stable. However, in an unstable environment in which there are repeated modifications of given applications and in which the number of applications are increasing rapidly (characteristics of most educational organizations), such an approach has the following limitations:

- A) Lack of flexibility. If management needs a slight modification of an application such as the changing of a form or report format, programs have to be rewritten to implement the change. The highly specific nature of the programs may require that entirely new data structures be constructed in order to accommodate even a small change in a given application and its programs. Both these processes are time consuming and expensive.
- B) Data redundancy. Different data sets often contain the same items of data, possibly with different formats. For example, programs to generate class lists, pupil program cards, report cards and permanent record entries would all need information about the classes a student is currently enrolled in. Maintaining the same information for several different programs involves duplication of effort and wasted storage space. In addition, if similar data items are updated at different times,

contradictory reports can be generated by the different programs.

- C) Program redundancy. Different managerial applications often have several processing procedures in common which requires that certain sequences of instructions be re-designed or repeated in several programs.
- D) Restricted access. Proliferation of programs and data sets tend to promote the use of batch processing techniques. Such systems make data available to administrators only at scheduled intervals and requires a massive manual support effort and technical staff to intervene between educators and the computer at the data input and retrieval stages.

In order to overcome these problems, modern management systems increasingly are using the data base concept. In such systems data are considered a basic resource, stored and maintained independent of specific programs or applications. The data base consists of a series of files, each of which contains the data items needed to perform related applications. Applications are viewed as combinations of data items that need to be accessed, manipulated or retrieved. A Data Base Management System (which is itself a series of programs) is responsible for automatically structuring the storage of the data items, accessing the data requested by application programs and users, and performing some of the more common processing tasks, e.g., "Sorts". This dramatically reduces the complexity of, and need for, application programs and enables changes to be made in programs without making concurrent changes in the data sets. This also reduces the problem of program redundancy, since applications that do not require elaborate mathematical manipulations (a characteristic of most applications in educational administration) can be performed by the Data Base Management System (DBMS) rather than by separate application programs.

Since most data Base Management Systems are designed so that non-technical personnel, can

interact with them, the problem of limited access is reduced. Communication with such systems is conducted in simple, English-like (high level) commands which are easily learned. On-line systems provide prompts to the user, immediate error detection and quick responses to questions posed to the data base. If time sharing is available, several users can simultaneously access the data base. It also provides a highly flexible and adaptable capability because a user can request any combination of data items or records to be processed and/or accessed (For a more complete description of the data base approach see references 4, 7.).

It should not be concluded from this too brief discussion that the DBMS approach is the ultimate in management systems, or that it is easy for organizations to install such a system. There are limitations and complications with such systems which can cause problems for unwary organizations (3). However, DBMS represents a significant step forward in system design whose concepts are being increasingly adopted by industrial and educational organizations (4). The number of commercially available DBMS software packages is increasing, cost is decreasing, and packages have been developed recently to operate on Minicomputers (1). As a result of the latter development, it is now feasible for even small school districts to use a DBMS.

DESCRIPTION OF MOSES

MOSES emulates the operation of a DBMS and provides the learner with the opportunity to engage in the following data base related activities using a terminal:

- a) Data Base Creation
- b) Data Base Modification
- c) Data Base Querying
- d) Report/Form Generation

In order to use MOSES one merely learns 14 English-like commands. Each command triggers an interactive dialogue sequence designed to perform a specific task. Upon completion of a given dialogue sequence and task, the system responds with YOUR COMMAND? at which point the learner responds with the appropriate command to trigger execution of the next desired task. Though few in number, the available commands are sufficiently encompassing and flexible to enable users to develop elaborate systems for most areas of educational administration.

The following is a brief description of the commands in the MOSES system:

- 1) DESCRIBE is used (1) to describe the characteristics of the data items (name, type, length) to be included in a given file and (2) to designate the item(s) to be used as a record key(s).
- 2) CREATE enters the data into the file, item by item, record by record in response to prompts generated in accordance with the structure specified in the DESCRIBE command.
- 3) PURGE removes a file from the system which is no longer needed.
- 4) DELETE removes a record with the specified key value from the designated file.

- 5) ADD adds a record to a designated file.
- 6) REVISE is used to change the values of designated items within a file, either for individual records, groups of records or all records.
- 7) SORT is used to sequence records according to the values of one or more designated items.
- 8) SELECT is used to obtain information about the records in a file which meet specified logical criteria. Information can be drawn simultaneously from selected records in several files as long as each of the files has the same item as a record key.
- 9) SAVE stores the subfiles generated by the SELECT command as system files. Up to three temporary files can be stored at a given time.
- 10) COUNT indicates how many records in a file meet logical criteria.
- 11) SUM can be used to obtain the sum for all the values of a given item or to add together 2 items in a record for all records in the file. In the latter case, the sum can be stored in a designated third item or can replace the original value of one of the items which was summed.
- 12) LIST dumps the entire contents of a file.
- 13) REPORT displays the values for the designated items in columnar form for an entire file or subfile. Provisions are provided for a report title, column headings and the printing of requested sums and averages.
- 14) FORM allows for more sophisticated formatting of output and can be used to generate a form for each record in a file. For example, a pay check can be generated for each employee, a report card for each student or a mailing label for each parent. Learners describe the form line by line using fields consisting of literal strings containing text that will appear on all the forms, and item names which cause the value of that item contained in a given record to be printed in the appropriate spot on the form being generated for that record. Full editing capabilities are provided for testing and modifying the specifications for a given form. Once developed, form specifications can be permanently stored for future use.

The following is a series of examples of the use of some of the commands. All information which appears after the question marks represent sample responses to the system. All other material is printed by the system.

This first example illustrates the setting up of a student enrollment file.

YOUR COMMAND?DESCRIBE

FILE NAME?ENROLL

HOW MANY ITEMS ON YOUR FILE?16

ITEM 1?ID NUMBER,5,A
ITEM 2?LAST NAME,16,A

ITEM 3?FIRST NAME,16,A
 ITEM 4?PARENT LAST,16,A
 ITEM 5?PARENT FIRST,16,A
 ITEM 6?SEX,1,A
 ITEM 7?BIRTH MONTH,2,N
 ITEM 8?BIRTH DAY,2,N
 ITEM 9?BIRTH YEAR,2,N
 ITEM 10?ADDRESS,30,A
 ITEM 11?ZIP CODE,5,A
 ITEM 12?HOME PHONE,8,A
 ITEM 13?EMERGENCY PHONE,8,A
 ITEM 14?GRADE,1,N
 ITEM 15?ROOM,4,A
 ITEM 16?READING LEVEL,4,N

HOW MANY RECORD KEYS?1
 KEY 1?ID NUMBER

ENROLL IS NOW DESCRIBED.

YOUR COMMAND?

The following procedure would be used to enter data into the file:

YOUR COMMAND?CREATE

FILE NAME?ENROLL

HOW MANY RECORDS?50

RECORD NUMBER 1

ID NUMBER?00001
 LAST NAME?GABALDON
 FIRST NAME?DELLA
 PARENT LAST?GABALDON
 PARENT FIRST?DAVID
 SEX?F
 BIRTH MONTH?06
 BIRTH DAY?15
 BIRTH YEAR?69
 ADDRESS?2624 MCDONALD RD NW
 ZIP CODE?87105
 HOME PHONE?344-6843
 EMERGENCY PHONE?345-2923
 GRADE?1
 ROOM?100
 READING LEVEL?1.1

RECORD NUMBER 2

This process would continue until the system data had been entered for 80 records (students).

In order to find out how many third grade girls there are, and what the reading score of each is, the following procedure would be used:

YOUR COMMAND?SELECT

HOW MANY FILES?1

INPUT FILE NAMES
 ?ENROLL

LIST ITEMS FROM ENROLL TO BE SAVED.
 ?LAST NAME,FIRST NAME,READING LEVEL

ENTER CONDITIONS FOR SELECTING A RECORD

?SEX=F *AND* GRADE=3

PLEASE WAIT WHILE SEARCH IS IN PROGRESS

4 RECORDS ON FILE.

HOW MANY DO YOU WANT PRINTED?4

LAST NAME	FIRST NAME	READING LEVEL
INGRAHAM	DIANE	02.9
LUJAN	FLORENCE	04.4
METZ	JEANNINE	03.5
STONER	LISA	04.1

4 RECORDS PROCESSED

YOUR COMMAND?

MOSES is a complex software package consisting of 39 programs which chain in a highly variable fashion depending on user response to system prompts. MOSES is written in extended basic and requires only 8K of main memory program space. It is designed to be used in a time-shared environment whereby several users can simultaneously use MOSES to develop and operate their own individual information systems. When MOSES is accessed simultaneously by 11 terminals, system response time is excellent with the exception of the SORT command which at times tends to keep the user waiting 30-60 seconds. (The H.P. 2000 computer will support up to 30 terminals operating simultaneously but this author has never had occasion to use more than 11.)

This author is currently using MOSES on an H.P. 2000 ACCESS system (It will also work on an H.P. 2000 F system). A magnetic tape copy of the system along with documentation (7) have been submitted to the Hewlett Packard Contributor Library. It is expected that copies of that material will be available to interested parties from that source by the summer of 1977. Work on converting the system to run on a DEC 10 computer, is underway. For further information on the system's availability, please contact this author.

UTILITY OF MOSES AS AN INSTRUCTIONAL DEVICE

MOSES is intended as a tool for demonstrating, and learning, techniques of applying the data base concept in computerized information systems. MOSES is not intended to be used as an actual administrative tool since it lacks several features that are important for actual production use. For example, MOSES is limited to relatively simple data structures (for a description of the more complex data structures used in commercial data base systems see reference 2). MOSES has no provision for random access files, restructuring of files, or interfacing with application programs. However, MOSES does emulate most of the basic operations of a DBMS, and supplementary

lectures can be used to provide instruction relative to features that are not illustrated by MOSES.

Approximately 8 hours of demonstration and practice on a terminal is sufficient to familiarize students with the use of a terminal and the MOSES commands. Approximately 10 more hours are needed for students to implement an information system of their own design. The general nature of MOSES helps users realize the basic characteristics of system design that are common to most applications. Students and administrators with no previous computer experience have successfully used MOSES to design systems for inventory control, program budgeting, personnel and student accounting and library management.

The response of administrators and students to MOSES has been excellent. They tend to be pleasantly surprised by the ease with which they are able to learn to use the computer and the sophistication they are able to achieve in a short period of time. The opportunity to learn by doing and engaging in an activity which provides for individualization and immediate feedback is appreciated. Pilot testing of the system made it possible to anticipate the specific misunderstandings and errors that would be made by students and to thereby design the prompts and error diagnosing capabilities of the system to minimize such problems. Although students differ in the degree of creativity with which they apply MOSES, all have been able to quickly learn to use the system. The resultant confidence tends to increase motivation to learn supplementary material presented in follow-up lectures.

In summation, experience indicates that MOSES is a valuable tool for providing experiential training in the design and operation of computerized data base management systems. It also demonstrates the feasibility of establishing on-line data base management systems in schools, which require clerks, teachers and administrators to interact directly with a computer, to those who will be making the decisions in the future on computer use in education.

REFERENCES

- (1) Boylan, David. "DBMS for Minis," Computer Decisions, January 1976, pp. 66-69.
- (2) Lefkonitz, David. Data Management for On-Line Systems, Hayden Book Company, 1974.
- (3) LoCasio, Nicholas. "Evolving a Data Base Management System," Infosystems, March 1976, pp. 53-54.
- (4) Nolan, Richard L. "Computer Data Bases: the future is now," Harvard Business Review, September-October 1973, pp. 98-114.
- (5) Pogrow, Stanley and Steven Flint. Documentation for Using MOSES, Submitted to the Contributed Library Unit of Hewlett Packard, 1976.
- (6) Schubert, Richard F. "Basic Concepts in Data Base Management Systems," Datamation, July 1972, pp. 42-47.
- (7) Withington, Frederick G. "Beyond 1984: A Technology Forecast," Datamation, January 1975, pp. 54-73.

MANAGING COMPUTERS AND COMPUTING

Elementary / Secondary

A COMPUTER NETWORK FOR HIGH SCHOOLS

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The Manitoba Schools Computer Network provides secondary school students, teachers and school administrators with the facility to access a large-scale computer from their own school. The schools are equipped with a slow speed batch terminal connected via dedicated transmission lines to the central computer. In order to provide equality of educational opportunity, terminals are located in schools which happen to be located physically near the computer. The card reader accepts both pencil marked or keypunched cards which the students use to encode programmes or to access the central programme library.

1. INTRODUCTORY FACTS ABOUT MANITOBA.

The province of Manitoba is geographically located in the south-central part of Canada, it is 246,512 square miles in area (i.e. approximately twice the size of Arizona) and has a population that slightly exceeds one million (i.e., approximately one half of the population of Arizona). The population in the province is distributed as follows: approximately half of the residents live in the capital city, Winnipeg, and the other half reside in much smaller communities which are predominantly located in the southern part of the province and whose populations are usually less than 25,000. As one would expect, student population distribution is similar to that of the entire population. Consequently, there are large schools with high enrollments in Winnipeg and there are smaller numbers of students attending many schools in the rural areas.

The computer education program is directed toward students enrolled in the last three years of secondary school education. This is a total of 46,166 students; 24,749 attend 36 schools in Winnipeg and the remaining 21,417 students attend 102 schools outside of Winnipeg.

2. HISTORY OF COMPUTING IN MANITOBA SECONDARY SCHOOLS.

In 1967, with the assistance of the Manitoba

Department of Education, a course called "Computer Science 205" was piloted in two secondary schools. In 1969, the course was approved as an option by the Department of Education for use in all Manitoba Secondary Schools. One year later "Computer Science 305" was introduced as a sequel to the introductory course. These courses are presently offered as options in the final two years of secondary education and are designed with the hope that students with diverse backgrounds would take them. However, these courses soon attained an elite status and at present are taken mainly by students planning on attending University. Consequently, in 1972 two Data Processing courses had been piloted and were subsequently approved by the Department of Education. The two new courses were designed for and in fact did attract, the students planning on entering the work force or the technical schools.

To facilitate the teaching of these computing courses in the past, each secondary school arranged for computer usage from nearby Universities, technical colleges and private industries.

In 1973, computing in Manitoba schools initiated an innovative phase when the Manitoba Department of Education announced a pilot computer program for Manitoba secondary schools. The program consisted of providing each of 23 schools (26 in the second year and 27 in the third year) with a remote batch terminal connected to a central computing facility by a dedicated line. Additionally, approximately 25

schools were able to submit jobs for processing to nearby schools with a terminal. In the process of creating the network, 3 objectives were defined:

- 1) to use the computer to teach computer science and data processing;
 - 2) to provide computer support services, especially those services which will help improve the efficiency of school operation and student performance;
 - 3) to provide school administrative services.
3. COMPUTER SERVICES BRANCH MANITOBA DEPARTMENT OF EDUCATION

The Computer Services Branch was formed to aid in carrying out the aforementioned three objectives. The branch initially had a staff of nine; a coordinator, a technical advisor, four program consultants, and three secretaries. Recently, the staff numbers have been reduced since the network is now running smoothly. The main function of the branch is to provide services to the schools within the network. The Computer Services Branch supports and educates the personnel within the network through three means:

- 1) Publication of relevant information

- a) Exposure courses
- b) MNF manual (MINNESOTA FORTRAN)
- c) Instruction Package

The document contains information relevant to a teacher using the network facilities.

- d) COBOL Manual
- e) The VAULT

This is a collection of graphics, games, and other "fun" programmes.

- f) PLUM (Programme Library Users' Manual)

This document contains 63 programmes fully documented and stored on disk for use by teachers and students in various disciplines.

- 2) Software Development

- a) Aid in designing in-school administrative packages.
- b) Improve network efficiency and operation through the development of system control language procedures.
- c) Student scheduling package.

- 3) In-Services

- a) Provincial in-services are held regularly

to keep teachers informed on new developments within the network as well as computing in general

- b) In-school in-services are held on a regular basis through visitations by the program consultants.

4. THE HARDWARE.

Each school in the pilot computer project is provided with a batch terminal. This decision to equip schools with batch terminals instead of interactive terminals was largely based on cost. Batch terminals permit more students to use the computer at the same time for less money and, in addition, the potential use of the terminal for in-school administrative applications is greater via a batch terminal. The school terminal consists of a Hewlett-Packard 7260A optical mark reader and a General Electric Terminet 1200 printer.

Optical mark cards were designed especially for the network and feature many of the facilities offered by the standard keypunch (McMaster and James [1975]).

The terminals are connected to the central computer via 1200 baud dedicated transmission lines. The terminals operate asynchronously in a half duplex mode which means that the reader and the printer may not be operating simultaneously. Each terminal accesses the computer through a dedicated port. The communications controller is a CDC 1700 which front-ends the main computer, a CDC 6500. The front-end is potentially capable of handling 150 terminals at 1200 baud. The CDC 6500 has 131K of central memory, 500 million characters of on-line storage, and 5 tape drives.

Figure 1 is a schematic diagram of network hardware.

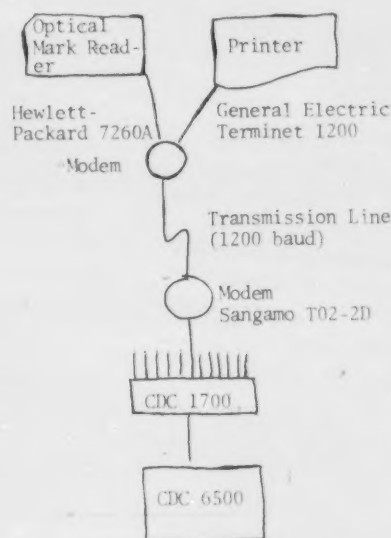


Figure 1: Diagram of Network Hardware

The limitations of transmission rate and mechanical operating capability of the terminals, translates into a speed of either 1 card being read per second or 1 line being printed per second at each site. However, the limited speed of each terminal restricts the number of jobs that can be submitted through any one terminal insuring an adequate processing time for all terminals. Hence, many users have the impression that they are the only user of the computer since their terminal is operating at maximum capacity.

5. THE OPERATION OF THE NETWORK

The operation of the Manitoba Schools Computer Network is dependent on four different groups. The Manitoba Telephone System owns and maintains the readers and printers which the schools rent directly from them. They also own the modems and provide the transmission lines. The Manitoba Department of Education pays the line charges and modem rent for all schools in the network. This is one way of equalizing educational opportunity since the remote schools are not asked to pay more because of increased transmission costs. The central computer is owned and operated by a computer utility which is totally funded by the Manitoba Development Corporation. The Department of Education pays a flat monthly fee for computer services provided to the schools. Control Data Canada is contracted to maintain the computer hardware as well as software maintenance on their standard product set. This maintenance is paid for by the computer utility and is included in the flat monthly fee. Finally, the Computer Services Branch of the Department of Education coordinates the efforts of the above participants as well as identifying and reporting all hardware and software problems that the schools may encounter.

6. A SCHOOL WITHIN THE NETWORK.

Students are often stifled in computer science because their access to the computer is restricted. There are very few limitations placed upon students using the Manitoba Schools Computer Network. The student can use any product set supported on the CDC 6500. These include compilers such as MNE, COBOL, FTN (FORTRAN EXTENDED), BASIC, and APL; pseudo assembly languages such as SPECTRE, SIMON, SAMDS, and MIX; system routines such as SORT/MERGE, SPSS, and BACKUP. The student has the highest priority possible when running a job. The student has the capability of creating both temporary and permanent disk files. In this regard, each of the 26 schools is allowed half a million characters of disk storage. The only real restrictions placed on the students are an 8 second compile and execute time limit and a 5 page limit on output when using the MNE compiler. Additionally the teacher is allowed the use of one magnetic tape and a 24 second time limit.

With a terminal so accessible, many schools have developed and are developing in-school administrative applications. Some of these include time-tableing, evaluation reporting, and budget control.

7. NETWORK USAGE

The following is a breakdown of average network usage statistics for the 1973, 1974, and 1975 school years.

Averages	Sept/73 to July/74 23 terminals	Sept/74 to July/75 26 terminals	Sept/75 to March/76 27 terminals
Jobs/month	44,311	44,107	57,437
Cards	1,409,752	Unavailable	2,632,604
Lines printed/month	3,130,343	Unavailable	4,810,116
System sec/job	.8	1.1	1.1

It is significant to note that of the cards read per month, approximately 20 percent were optical mark cards.

8. CONCLUSION

In our opinion, the most effective way to teach computing is to have access to the computer directly from the school. Batch terminals have been and are continuing to provide an effective method of accessing the computer for students in Manitoba. Once the facility is in the school the computer can be used to augment the teaching of other subjects as well as being used for in-school administrative applications.

9. REFERENCES

McMaster, G.E., and James, L.O. [1975], *An Optical Mark Card Design for High Level Language Encoding*, Canadian Journal of Operational Research and Information Processing, Vol. 13, No. 1.

A MINI-NETWORK FOR EDUCATIONAL LEVERAGE

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The philosophy, operation and benefits of a small network of directly linked mini computers will be described. Especially featured will be the operational considerations, administrative advantages, and educational impact of such a system.

INTRODUCTION

The focus of this report is on the uses of an ability for multiple mini-time-sharing systems (Hewlett-Packard 2000 series) to communicate with each other. Too often in the application of electronic data processing in education, equipment manufacturers have provided a hardware capability and left it to the educators to find an appropriate use for that capability. The HP 2000 system's capacity to communicate with other HP 2000 systems directly is an interesting feature. Other mini computer systems could provide this also. The question educators would immediately have, however, is "Why?"

This paper is an attempt to answer that question in a preliminary fashion. At this point, we don't have the slightest idea what the major eventual use of this feature will be. Our past experience has indicated use will be made in relationship to our willingness to suggest and promote uses. We also know some uses will be suggested which we did not anticipate.

The uses we foresee are extensive and quite important. It is these uses we will present here. With some years of experience, we shall return to report on the size and shape of the real uses.

Before we discuss the benefits we are deriving from this combined system, we will first briefly describe the two facilities.

DESCRIPTION OF THE FACILITIES

This project involves two Hewlett-Packard 2000 series timesharing systems. Each system can support up to 32 simultaneous users - executing or writing

programs written in BASIC. The systems differ in their actual hardware configuration as well as in the emphasis placed in each in the programs developed. On the other hand, there is some duplication of effort in developing new material. There is also some overlap in function and some problems in the co-ordination of joint efforts.

EDP Resource Center
San Francisco Unified School District

The EDP (Educational Data Processing) Resource Center of the San Francisco Unified School District operates an HP 2000 series computer located on the campus of Woodrow Wilson High School. The system has been in operation since 1971. The function of the EDP Resource Center is to provide educational computing to the secondary and elementary schools in the SFUSD.

Center For Business Education & Research
University of San Francisco

The Center for Business Education & Research (CBER) operates an HP 2000 series system located in the College of Business Administration at the University of San Francisco. The broad purpose of the Center is to develop technology based enhancements to education. In addition, the CBER computer is developing administrative support services for several secondary schools in the Archdiocese of San Francisco.

The two systems combined can serve 64 terminals simultaneously and contain programs and materials which cover needs of students and staff at the elementary, secondary and college levels. Each system, by itself, has limitations in capacity which are currently placing a ceiling on developmental efforts.

These limitations are complementary. For example, the EDP Resource Center has demands for terminals in excess of its capacity. The CBER has a surplus in this area. The CBER has very limited on line storage. The EDP Resource Center has a much greater on line storage capacity. The EDP Resource Center has a wealth of student operators and programmers. CBER has limited personnel in this area. CBER has a strong research and development capability, but few to implement it, while the EDP Resource Center is better staffed for implementation than for R & D.

In each of these broad areas, a strength of one system tends to match a weakness in the other system. The ideal program would be one which integrates both systems so that the total system would be able to serve its clients better.

The ability for the two computers to "talk" to each other means that the strengths of one can become the strengths of both.

SECONDARY SCHOOL BENEFITS

Technical Assistance

Secondary school computer projects tend to be technically understaffed. In most cases, dedicated and hardworking student staff perseveres under an equally dedicated faculty supervisor. There can quickly develop in such an operation a technology gap where problems reach beyond the expertise of the available help. The mini-network provides an immediate solution to technical problems where programs in files can be transmitted to the programming staff of the university for diagnosis and correction.

The network allows, through message capabilities at the console and program transfers, a free and rapid exchange of technical assistance.

Maximizing Storage Utilization

Proper scheduling by either institution can provide extra flexibility in the use of available system storage to temporarily make space available. This can be extremely helpful in a situation where one system has excess storage and another has periodic need for large files. One school, for example, maintains attendance programs on the system, but only transfers the large student file to the system once a month when reports are generated. Magnetic tape loads are inadequate since updating the student files might be done at any time

throughout the month. On-line transfers using the Link-Net allows for file loads and updates without interfering with the timeshare operations.

Advanced Placement

For a number of years, various programs have been established throughout the country that allow students to take advanced course work at a neighboring college or university while still attending high school. The increased cost of transportation and concerns about fuel consumption provide the impetus for delivering the curriculum to the students at their home school. Colleges and Universities are developing introductory programs in statistics, mathematics and other areas which are accomplished via computer assisted instruction. The Link-Net system allows a school to offer advanced placement courses for even one student merely by the transfer of the necessary programs from the University computer to the special student group.

Counseling Functions

The whole question of guidance, counseling, and student recruitment can be particularly enhanced by a Link-Net arrangement. High School students who anticipate enrollment at a local college or university could be given a questionnaire as part of the school's counseling service. This questionnaire would detail information as to possible majors, choice of electives, need for financial assistance, etc. These files, once established, could be transferred on the Link-Net to the college producing a summary report. The college could then dispatch a counselor to the school with the needed information and a list of prospective students.

Shared Peripherals

In numerous cases, special output devices such as plotters, high speed punch paper tape units, line printers, graphics terminals, etc. can be shared in a Link-Net system. Example: A high school mathematics teacher who has only occasional need for plotting capability can have a program transferred to a system supporting a plotter. The "RUN" and output could be returned within a day by mail.

Shared Library

Very often, statistical programs and other specialized computer programs are used frequently at the university level but infrequently at the secondary school level. Transfer via magnetic tape is cumbersome and leads to delays which can diminish the effective use of the programs. By having such programs transferred immediately from the University facility where they are maintained to the secondary school, the current version is always available for almost immediate use. With this capability the secondary school center need not maintain either the programs infrequently used nor the expertise in how to use them.

UNIVERSITY BENEFITS

Many of the benefits the University derives from the capability for the two computers to form a Link-Network are the reciprocal of the benefits accruing to the secondary schools. In general, however, the major area of benefit is in the vertical integration of the educational effort. Much of the activity of the University has impact and implications before the students enter as well as after they graduate.

Liaison with Schools

We expect to be able to establish a closer liaison with the schools through this facility through both communication and production. Even the telephone can not promote communication with the impact of a sophisticated message facility on a computer system. Program products of the University will promote similar closer ties since the direct link will provide the responsiveness school staffs need to resolve their problems.

To be part of the local community for a University should mean being part of the local educational community. The direct communication between computers will facilitate this by providing response time from the University to school requests for computing assistance in a matter of minutes rather than days.

Program Testing

Programs of various sorts are constantly being developed at the University level. There can often be a considerable lag between the completion of a program and significant feed back on its use. If problems develop, similar delays can be experienced in getting the problems corrected.

The direct link between computing facilities reduces this delay to minutes which can facilitate program testing. Rather than having to await the next class period, a teacher could have a problem corrected within the class period in which it occurred.

Shared Peripherals

The advantages for the secondary school in sharing specialized peripherals are just as true for the University.

Shared Libraries

The specialization of each institution would be reflected in the library each maintains. Occasionally, especially in the case of remedial language arts or mathematical exercises for foreign students, the University would need material developed at the secondary school level. This material would be massive to maintain and store on-line for a few students but would be quite manageable to transfer module by module as the University students needed.

ADDITIONAL BENEFITS

The users of the system are the ones who derive the greatest benefit. There are benefits in the total system that go beyond those which can be enumerated as the distinct benefits of each participating institution. Immediately, the users of the each system are able to access computing through 64 locations rather than through 32.

In addition to twice the access points, each user has the expertise of two computer installations, the range of two catalogs of programs and the ability to receive from an access point a spectrum of computer applications ranging from elementary school through college.

OPERATIONAL CONSIDERATIONS

Since the operation is designed to take maximum advantage of two separate computing systems operating as close as possible as one, coordination becomes a major concern. There are three main areas in which we have concentrated our attention to enhance this coordination: staff, storage, and peripherals.

Staff Coordination

Much of the successful operation of directly linked systems depends on operational staff. Often, in small timesharing installations, this staff is part time and students. Each staff has its responsibilities within an installation. To these responsibilities and priorities must be added the appropriate responsiveness to requests for activities on the linked network. The final impact of the capability will be determined by the integrated manner in which the two separate staffs integrate their efforts.

Storage Discipline

With files of information and programs being circulated back and forth in the system, the very duplication each installation seeks to avoid can be reintroduced by careless retention of transferred information after it has been used. Monitoring the users - reinforcing disciplined use and correcting undisciplined use - is critical.

Peripheral Coordination

One of the chief advantages is that specialized peripherals at one location can be used by both systems. This does require careful coordination of such use so that requirements for immediate availability of these specialized devices do not overlap. Responsiveness and service are two prime commitments of the joint operation of the linked systems. Uncoordinated allocation of specialized resources can reduce the joint system impact in both these areas.

A well coordinated staff effort will make the system yield the advantages it promises. Lack of the coordination can make the joint effort an unprofitable burden to both systems.

ADMINISTRATIVE ADVANTAGES

The operational considerations also form the possible administrative disadvantages. The advantages also deserve mention. The main advantage is the reduction of duplicated effort and the facilitation of efforts to bring a variety of expertise and capability to bear on a particular problem. Experience and capabilities developed in monitoring student progress at the secondary school level can be used at the University level with little problems since the programs can be maintained on the secondary site and used to update the data base easily at the other site.

Budgeting and accounting packages developed for instructional use at the University level can be put to operational use in the secondary school.

EDUCATIONAL IMPACT

The main impact is in the improved quality of the overall service of each system to its users. Each system is free to develop its own unique capabilities and contributions to the Educational use of computers yet both systems can take immediate advantage of the developments of the other.

There will also be a certain amount of impact from the challenge of having a parallel system operating so close that improvements in one system are immediately available to the other system which can then be challenged to further improvements.

CONCLUDING REMARKS

The final word on any application of computing to education in these days of shrinking educational dollars must be on cost effectiveness. Is more service being provided for less money? For our particular circumstances, the answer to this question is certainly yes. For a minimal investment, each system has essentially doubled its terminal capacity. The other benefits are less simply evaluated in quantitative terms.

Were we starting from scratch, we might look toward one centralized system to meet our requirements over two separate systems. Two factors would still argue in favor of the two systems in a linked network rather than a centralized facility: autonomy and SMRT (Single Message Rate Timing).

We expect to be able to save on some telecommunications costs by having facilities located within the same central exchange as the schools served. Some of the mileage charges associated with leased lines and "off-prem" extensions will be minimized by dispersing central facilities.

While cost saving is important, the most important feature of the link-network is that each installation retains complete autonomy. All the resources are shared and shareable but neither installation has to subvert its main function to a common, centralized facility. We feel this is the single most important advantage of using the linked-network over combining resources into one central computing facility.

COMPUTERIZED RESOURCE ACCOUNTING SYSTEM

Ralph Teter

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This paper describes the computer resource accounting system presently being used by the Gulf Texas Multi-Region Processing Center to serve its school district clients. This system forms the basis for customer billing, performance analysis, and analysis of cost by computer applications (e.g., grade reporting, attendance accounting, payroll, special applications). It is considered unique in that the capability is provided for inserting indirect cost factors, such as keypunch cost, so that billing reports reflect all of a district's direct and indirect costs for a given application.

"What is it really costing my district to do grade reporting by computer?" "What is the cost to do financial accounting?" "What is the cost to my district for our special program designed to 'gyre and gible in the waab?'" The Gulf Texas Multi-Region Processing Center computer resource accounting system answers such questions.

It is clear that costs involve more than just how much central processor time a job takes. Also relevant is paper usage and the amount of connect time if using a telephone line from a terminal. Charges for computer maintained information storage for special services such as keypunching and special programming, and for general services need to be included as well. If a district wants something a bit different in terms of output, then they can be charged through the accounting system. It is more, however, than just charging. For example, if a district wants to do its own keypunching but wants to make an entry in the computer file against grade reporting to show the total charges, they can make such an entry. This is not just a billing system--it is an accounting system.

The system itemizes all charges accumulated by the user during the reporting period. There are five basic charges:

1. For program execution.
2. For forms usage.
3. For connecting terminal to central processor.
4. For computer-maintained data storage.
5. For general services (e.g., keypunching, programming).

A brief description of the Texas State Plan for Data Processing Services is in order. The State, through legislative action, provides financial support to regional and multi-region processing centers. These centers serve many districts on a cooperative, shared-cost basis. A district, through board action, pays a basic charge to a center for a specific service or a "package" cost that covers several applications. The State provides additional funding by formula based, in part, on district participation by service. The Gulf Texas Center serves 101 districts with a

total enrollment of more than 600,000 in southeast Texas.

Districts participating in the Gulf Texas Multi-region Processing Center secure services via two basic plans: (1) application packages purchasable at a unit price, and (2) discrete computer services at contractual rates. The first represents a charge by package of standard services; the second, a charge by service performed (independent of the type of output). The latter embodies the "utility concept"--plug into the service and do what needs to be done. This concept is particularly applicable to operating networks like Control Data Corporation's CYBER 170 series.

Users are allocated sufficient resources to assure that the "standard" products can be provided without exceeding the basic allocation based on the "package" cost. The accounting system was designed around a unit price-by-application based on actual experience. It includes an average allowance for system/user error.

Users who choose the utility concept by purchasing computer services direct--not products at a unit price--are charged at fixed rates for each service. In either case, users receive monthly listings summarizing usage, overages, and year-to-date expenses.

Three goals were set for the resource accounting system:

1. To maintain a record of computer transactions that will provide a meaningful basis for billing the user.
2. To provide an accounting system that gives the detail necessary to analyze both direct and indirect costs by application.
3. To have a system flexible enough to allow credits when needed to accommodate for both unit pricing and contractual rates.

The system tracks costs relating to application packages, computer usage, expendables, and user peripherals from internal logs maintained by the KRONOS operating system. Using this system, it is possible to establish charge numbers (a billing entity) and projects with defined limits and spending ceilings. Charges are divided into projects designed

by the user and further sub-divided into activities. The system can be used, also, to track usage of standard products.

An examination of each of the charge categories indicates the detail available through the system (See example on following page). First, the project for which the execution charges are made is noted. As examples, a district may be using the computer for student attendance, computer assisted instruction, financial accounting, fixed assets accounting, and remote job entry, as well as other programs.

Other items relevant to execution charges are listed below:

Job name/point of origin (e.g., onsite batch, time-sharing terminal).

Date introduced into system.

Date completed--date charged.

Primary user number of job.

Count of permanent file activities.

Count of removable pack activities.

Region IV workorder.

Number of cards read.

Kilo units of mass storage activity.

Seconds of CPU utilization.

Number of system resource units (SRU).

Priority.

Charge status.

Time introduced into system.

Time completed--time charged.

Error flag at termination.

Time in system (minutes).

Operator intervention count.

Magnetic tape mount count.

Service charge for special products in SRUs.

Kilo units of tape activity.

GTMRPC RESOURCE ACCOUNTING SYSTEM
DETAIL LIST FOR 101912

XXXX ISD

REPORTING PERIOD

76/10/17 - PAGE YY
76/09/01 - 76/09/31

ADA

EXECUTION	ACTY	JOB NAME	M DATE	IN	DATE	OUT	USER	NUM	PF	RP	WKO	CARDS	MS	UNITS	CP	UNITS	SR	UNITS	SRU	CHG
			PR S TIME	IN	TIME	OUT	EF	ET	01	MT		SVCHG	MT	UNITS	PF	UNITS	DISCOUNT			
		BABIAGME A	76/09/01		76/09/01	UCHISD4						11	0.007		0.001		1.000			
			00.45.33		00.45.38			1									0.050			0.950
		AFYA053T A	76/09/15		76/09/15	UCHISD4			1				0.057		0.004		1.000			
			17.46.16		17.48.53			2							0.005					1.000

EXECUTE TOTALS FOR PROJECT ADA

92 1090 706 614 3693 1246.607 244.662 669.928
2 28.351 33.453 \$63.64

ADA

FORMS CHARGES	ACTIVITY	JOBNAME	SM	DATE	CUT	TIME	OUT	IO	FORM	EQ	COUNT	CHARGE
	PROONA103	AFHABOJE A		76/09/01		11.43.48					16	\$ 0.05
	PROONA103	AFHABMQE A		76/09/01		13.43.44					87	\$ 0.05
	PROONA103	AFHABWFE A		76/09/01		17.03.24					93	\$ 0.05
	PROONA103	SUBTOTAL							3 CHARGES		196	\$ 0.15
	PROONSS28	AFYABGNB A		76/09/27		01.51.58				31	640	\$ 0.07
	PROONSS45	AFYAFWPB A		76/09/26		12.31.05				32	2816	\$ 0.31

FORMS TOTALS FOR PROJECT ADA

20 CHARGES 8340 \$ 1.50

ADA

CONNECT-CHARGES	ACTIVITY	JOBNAME	SM	DATE	IN	TIME	IN	DATE	OUT	TIME	OUT	TERMINAL	C-IN	C-OUT	MIN	CHARGE
		AFYA053T A		76/09/15	17.46.16			76/09/15	17.48.53			TT LO SPEED			2	\$ 0.06
		AFYA053T A		76/09/15	17.49.46			76/09/16	05.35.04			TT LO SPEED			706	\$23.53
	PROO	AFYA053T A		76/09/25	08.05.22			76/09/25	08.07.46			TT LO SPEED			2	\$ 0.06
	TST	AAA1005T A		76/09/02	11.43.39			76/09/02	15.28.06			TT LO SPEED			225	\$ 7.50

CONNECT TOTALS FOR PROJECT ADA

LO SPEED 9 CHARGES 1065 \$35.50

Kilo units of permanent file activity based on origin and priority.

Total charge in SRUs.

The system resource unit (SRU) is the unit by which resources are measured when a product is being executed on the central processor. It includes all machine and most operator activities. The SRU uses cost incentives to encourage certain user practices. As an example, an onsite (local district) batch SRU requires only 90 percent of the resources of a local batch SRU at the central site. This decreased cost is an incentive to encourage remote job entry (RJE) use. On the other hand, the use of the time-sharing teletypewriter in applications that could more economically be performed on the RJE is discouraged.

The relative worth of an SRU is dependent, also, on the priority given to a job by the user. The three-hour turn-around SRU on a batch job is more expensive than an overnight SRU. Users determine their job priorities with greater realism when the dollar sign is attached. These savings to the user appear in the accounting system as discounts.

The second charge area concerns the use of forms. The report includes activity, job name, charge status, and machine code as in execution charges. In addition, the following elements are reported:

- Date completed--date charged.
- Time completed--time charged.
- Form control code.
- Form name.
- Equipment used.
- Forms used (lines printed).
- Dollar value of forms.

For connect charges, the activity, charge status, and machine code are repeated along with the date and time logs. To provide the user with a complete picture, the following items are listed:

- Job name in system and terminal number.
- Terminal type and qualifier.
- Minutes of connect time.
- Dollar value of connect time.

The fourth area covered by the resource accounting system is permanent file storage charges based upon millions of characters per day. This includes file counts and their size for both direct and indirect access. In each monthly report, a daily average and total is provided.

General services charges enable a wide range of unique charges to be input. These listings might include (with examples):

Activities (keypunching by either the center or district, priority programming, removable pack lease, teletypewriter lease).

Charge for unit of service (cost per card, charge per hour).

Assignment of charge (by program application, by campus, by monthly proration of a standard contract).

Number of units charged.

Total charge for activity.

The number of charges is summed for the reporting period along with total charges for general services.

Several types of reports are available from the resource accounting system. Most are usage-oriented and designed to help in costing and planning. Some are summary (that a superintendent might use) and some are detailed (that data processing personnel and/or business managers might use). The detailed report gives an item-by-item ledger of all system activity. Districts receive monthly and year-to-date summaries where totals are listed by application and service with overages noted. Dollar amounts are used whenever possible for clarity. In addition, a system-maintained data base allows the user to inquire at any time on month-to-date SRU utilization.

In addition to its immediate value for users, the system provides useful information to the computer center itself. Since the biggest expense is computer run time, the center is interested in determining software efficiency, and the accounting system can analyze it. Software can then be streamlined. Performance data by application can be analyzed to determine whether it might be less expensive to do an operation manually, or to reduce the number of runs for a user. Finally, with the advent of this or similar systems to compare the performance of a given application at different

sites considerable economies can be achieved. Such a comprehensive resource accounting system should prove of great value to school districts and other agencies held accountable for the detailed expenditure of public funds for education. This computerized resource accounting system is one in which hardware, software, and people truly function together.

IOWA PLAN
FOR THE STATEWIDE USE OF THE
COMPUTER FOR EDUCATION

Dean D. Crocker
Iowa Dept. of Public Instruction

The timely information now possible in applying high speed computer techniques to education may benefit students, school administrators, supervisors and other decision makers alike. Teachers and students may find assistance through the use of instructional and career guidance applications. Education administrators, supervisors, teachers and other community and state planners can benefit by using the available data in projecting alternative solutions for critical planning issues.

Use of the Computer for Education in Iowa

Iowans started using the computer for education applications in the early Sixties. As computer centers were established in certain sections of the state, Iowa legislators were concerned with their unscheduled growth. Legislation passed by the General Assembly in 1972, charged the Department of Public Instruction with the responsibility of approving, coordinating and supervising the use of educational data processing in public schools and education agencies (K-14).

The legislation further mandated the appointment of a five-member State Advisory Committee on Educational Data Processing to conduct inventories of current practice, and to prepare and recommend a statewide plan for the coordinated use of electronic computers in education for both administrative and instructional application. The Committee was charged further to assist and advise the State Board of Public Instruction in approving, coordinating and supervising the use of computers by Iowa public school districts and education agencies.

The appointed committee developed an Initial Report by December, 1972, which was sent to the Iowa General Assembly in February, 1973. The report included an inventory of the computer centers that had been providing service to Iowa public schools (K-14). The Initial Report and an unpublished second inventory completed in January, 1974, both indicated that many students, teachers and administrators in Iowa have been denied access or have chosen not to use computer services.

Development of a Plan

In the winter of 1975-76, an ad hoc Task Force appointed by the Superintendent of Public Instruction prepared a statewide plan. The objective was to coordinate the efforts of all agencies under the jurisdiction of the Board of Public Instruction (K-14) in order to provide equitable and efficient computer education services. The Plan covers both administrative and instructional applications of computer services and includes a listing of possible types of records, reports or instructional uses in each category. Criteria and specifications desirable for the selection and development of computer software are proposed. Concurrently, the Iowa Administrative Code was modified to incorporate procedures relating to the planning and delivery of computer services to Iowa public schools and education agencies.

Design of Plan

In the Iowa Statewide Plan, computer services are categorized into two broad areas - Administrative and Instructional. An Administrative System would include subsystems for processing data on finance, personnel, students, educational programs, facilities and community factors. The Instructional System would provide services in the areas of computer literacy, computer assisted instruction, computer instructional services, computer assisted guidance, computer in-service training and computer career preparation.

The design for the provision of computer services statewide is based on a Regional Computer and Area Service/Delivery Center concept. When the network is implemented,

one or more Regional Computer Centers will be available to offer large processing and core storage capacity. The Regional Center(s) will also be able to provide uninterrupted backup services to any of the other smaller computers in the system. Area Service/Delivery Centers with lesser computer capabilities will actually deliver the services needed by local schools, education agencies and corporations.

Local school districts will plan annually for their anticipated computer use and needed services. Their Area Education Agency has the responsibility within reasonable financial limitations of arranging for the delivery of the necessary services through an Area Service/Delivery Center. In addition, each Area Education Agency must plan for those services used by its own organization. The Merged Area School Corporations are to arrange for the administrative and instructional services for the programs under their jurisdictions.

The organization to implement, coordinate, operate and maintain the system proposes a hierarchy of financial and administrative responsibility. The Plan suggests that the Iowa General Assembly will be asked to provide the funding necessary to develop the services the State needs for up-to-date planning and decision making on education issues, and its share of the responsibility for making computer services equally available to all public education units (K-14) in Iowa. It is the responsibility of the staff of the State Department of Public Instruction to coordinate the transition from the present to the full implementation of the statewide system.

Implementation of services will start with one or more Regional Computer Centers. These Centers will have computer, core and secondary storage capacities beyond the capabilities of the Area Centers. The Regional Center(s) will need to be responsive to user needs and receive direction from a board of advisors that recognizes the collective needs expressed by the Area Education Agencies (intermediate school districts), Merged Area School Corporations (Community Colleges and Vocational-Technical Schools) and the local education units.

At the Area Computer Centers, the Area Education Agencies will pay for the costs 1) involved in delivering administrative services to their own agency, 2) for instructional services used, 3) for remote terminals, 4) for the development of any unique or program capability, 5) for the staff necessary to provide its service/delivery function, and 6) for a part of

the telephone line cost from the Regional Center(s).

The local school districts will reasonably be expected to pay for the cost of the remote terminals located in local education units. They will pay an equitable share of telecommunications costs from the Area Service/Delivery Centers, and the administrative and instructional services used exclusively for their own school applications. The Merged Area School Corporations will pay for the computer costs involved in career education and the staff necessary to operate and maintain any service/delivery function for which the Corporation is responsible.

Why a Statewide Plan?

Education administration and education services have become large and complex businesses. Administrators, supervisors, teachers, students and interested community citizens can benefit from the well-planned use of the computer in the consideration of possible solutions to complex education situations.

In the school setting, the timely information now possible through the use of the high speed computer can assist administrators in making the most effective use of the time, personnel, finances and facilities under their jurisdiction. When planning for student learning, administrators, supervisors and teachers are recognizing that the flexibility of programming available through the thoughtful application of the computer can offer students new and meaningful learning experiences and guidance information.

In the community environment, citizens responsible for education planning, governance and assessment at local, regional, state and federal levels appreciate all the help available as they, too, are faced with large and perplexing decision-making problems.

In conclusion, the plan is characterized by: 1) its flexibility, 2) its potential in allowing a high degree of local autonomy, 3) its awareness that needs differ from school unit to school unit, 4) its availability to all units through cooperative local, regional and state efforts, and 5) its potential for efficient, equitable and effective implementation.

Copies of the Plan have been distributed to each state. Interested individuals may obtain copies by contacting their state coordinator for the Committee on Evaluation and Information Systems (CEIS) or by writing directly to the Director, Regional Computer Centers, Department of Public Instruction, Des Moines, Ia. 50319.

MINIMIZING TRANSPORTATION COST WITH COMPUTERIZED ROUTING

James K. Byers
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A computer model has been developed to assist in the routing of transportation vehicles. The model is being used to design some of the bus routes for schools and delivery routes for companies. The results of two applications are presented.

1. INTRODUCTION

During the school year 1973/74, approximately 42 million dollars were spent on pupil transportation in Missouri public schools. Of this amount 27 million dollars were paid for by reimbursements from the state to the local schools while the remainder was paid out of local schools' budgets. A rural school in Missouri that transports 1,000 pupils will have a yearly transportation expense of about \$100,000. With the increasing cost of energy, these costs can go nowhere but up.

These types of staggering cost figures provided us with the incentive to develop a computer model for optimizing the routes for a fleet of vehicles. This project began as a research project during 1973 in the Computer Science Department at the University of Missouri-Rolla. During the last year, it has matured into an operational model that is now being used for school bus routing as well as for routing delivery trucks. The results of two case studies are presented in this paper: (1) routing of school buses for Crawford County R-II School District and (2) routing of trucks for DeLeo Distributing Company who distributes Stag and Olympia beer.

2. AREAS OF APPLICATION

There are many different areas where computer routing can be used. Some of the most prominent ones are:

- (1) School buses
- (2) Bottling distributors
- (3) Beer distributors
- (4) Gas/propane distributors
- (5) Milk distributors
- (6) Bread distributors
- (7) Grocery chains
- (8) General wholesale distributors

The unique features about each of these applications is that they either run regular routes or routes are based on orders that are received over some period of time. When regular routes are established, such as for school buses and most distributors, the routing analysis needs to be done only periodically. When routes must be established based on orders received over some time, a real time routing model must be established which would require an inhouse computer facility.

There are some clues that can be used to spot an inefficient set of routes. The most significant ones are:

- (1) Can any of the vehicles haul a larger load?
- (2) Do any of the routes criss cross or double back?
- (3) Is the percentage of time the vehicles are driven while empty too high?
- (4) Are any of the vehicles parked too much?

It has been our experience that anyone who does not conscientiously analyze their routes periodically will have an inefficient set of routes.

3. PROCEDURE FOR ROUTING STUDIES

The analysis of a set of routes, whether it be buses or delivery routes, consist of four major steps. They are:

- (1) Data gathering
- (2) Data processing
- (3) Design of routes
- (4) Implementing the results

Most of the workload of data gathering is on the customer. The data that must be gathered are:

- (1) Location of customers
- (2) Quantity to be delivered to or picked up for each customer
- (3) List of the vehicles available and their capacities

The best way that we have found to collect the data is to let each driver record the location of the stops on his route and the demand at each stop. In the case of bus routes, the demand would be a list of the pupils at each stop while for delivery routes, it is the number of packages to be delivered.

The data processing phase consist of (1) punching the demands up on cards, (2) developing a master map that contains the stops for all routes, and (3) developing the distance matrix for the distances between stops. One card is punched up for each stop that gives the total demand for the stop. There can be more than one type of demand. For bus routes, the different types of demands refer to different schools that pupils attend. For delivery routes, the types of demand refer to the different types of packaging.

The master map is required to develop the distance matrix that is required for estimating the distances of the routes. The map is placed on a large digitizing tablet connected to a Nova minicomputer. Distances between adjacent stops are recorded in the computer by tracing the tablet pen over the roads that can be traveled. This provides an accurate and efficient means of computing the distances which is far superior over manual and approximate methods that are currently used by other analysts. A detailed discussion of the method is presented in reference 1.

After all the data has been processed and put on cards, the design of the routes begins. The initial step is to obtain a set of routes generated by the computer. The savings method presented by Clark and Wright [2] is used to obtain this initial set of routes. Constraints can be placed on the vehicles capacities and distances. Under most conditions, this method provides excellent routes; however, manual adjustments are always required.

Colored pens are used to draw routes on plastic overlays of the master maps. This provides good visualization of the routes such that appropriate adjustments can be made. The adjustments can be for a variety of reasons -- further reduce the distance, eliminate hazardous conditions, provide special consideration for a customer, etc. After all manual adjustments are made, the new routes are read into the computer and new loads and distances are computed. This man/machine interaction is continued until an acceptable set of routes is obtained.

The preliminary set of routes is presented

to the customer for his review. This review usually prompts further man/machine interaction with the routes. After the final set of routes is completed, a final report is presented to the customer. The final report contains a map with the routes color coded, stop-by-stop data on each of the routes and a summary sheet for the routes.

4. CASE STUDY I: CRAWFORD COUNTY R-II SCHOOL DISTRICT

The Crawford County R-II School District transports almost 1,000 pupils per year. During the 1975/76 school year, 16 bus routes were used. After computerized routing was used, the number of routes was reduced to 15 and the total mileage was reduced by 38 miles which was a 6% reduction in mileage. No significant problems were encountered by the school district in implementing the new routes.

The data gathering for the Crawford County R-II School District began in the Spring of 1976. Each bus driver was requested to locate the stops on his route on a map and to list the pupils picked up at the stops. County maps obtained from the State Highway Department were used for the county routes. A town map was used for the town routes. The data was checked by the transportation director before we received it. The data was fairly accurate as was proven later.

Each pupil's name was punched up on cards along with the stop number we assigned to their stop. The cards were used to get the total demand at each stop which is what is used by the routing program. The only other place that the pupil's name is used is to give a list of the pupils at each stop for the final set of routes.

The distance data was processed on the digitizing tablet as previously described. The tablet provides an accurate means of estimating the distances of routes. Table I shows a comparison of estimated distances using the tablet versus actual distances as measured by the odometer on the school buses for the final routes implemented. The final estimate is within about 3% with explainable differences included. When explainable differences are removed, the estimate is close to 1% of the actual. Certainly this is within acceptable limits.

The design of the routes begin by obtaining a computer solution as previously discussed. The computer solution had more turnarounds than could be tolerated. Manual adjustments were made to reduce the number of turnarounds plus further reducing the mileage. This preliminary set of routes was presented for review to Mr. Benny Gooden, Superintendent of the Crawford County R-II school. These routes had an estimated savings of 70 miles.

TABLE I
Comparison of Actual Versus
Estimated Distances

Bus	Actual Mileage	Estimated Mileage	Difference
1	35.2	33.7	1.5
2	78	72.8	5.2
3	70	68.7	1.3
4	35.6	36.4	-0.8
6	82.5	72.2	10.3*
7	28	31.1	-3.1
9	34	32.6	1.4
10A	9.8	8.7	1.1
10B	8.8	7.6	1.2
11A	9.4	8.8	0.6
11B	7.2	7.3	-0.1
12	63.6	65.1	-1.5
13	75.6	70.5	5.1
14	54.6	57.9	-3.3
15	60.4	58.4	2.0
	652.7	631.8	20.9

*Stops were added to the actual route.

Comments received back from the superintendent were (1) one route took too much time, (2) a hazardous crossing was being utilized, and (3) one turnaround that was specified could not be utilized. Manual adjustments were made to the routes to take care of these conditions. The adjustments required adding approximately 15 miles to the routes. The final set of routes was acceptable and the school district made plans to start the school year with them.

A comparison of the 1975-76 routes and the 1976-77 routes is given in Table II. Note that while eliminating almost 6% from the routes, the number of turnarounds did not increase and the average distance that each bus travels per day does not increase. Verbal comments received from the superintendent were that no major problems were involved with implementing the routes and the new routes provided better transportation service for the pupils on the average.

TABLE II
Comparison of Routes for
Crawford County R-II School

	1975/76	1976/77
Total number of pupils	935	944
Number of buses	12	12
Number of routes	16	15
Number of turnarounds	20	20
Total approved miles (per day)	292	269
Total miles (per day)	690	653
Average miles/day	43	43
Density	3.20	3.51
Total Cost	67,234	63,628

5. CASE STUDY II: DELEO DISTRIBUTING COMPANY

DeLoe Distributing Company distributes Stag and Olympia beer over a seven county area in East Central Missouri. Three trucks are used to deliver Olympia to 125 customers. The trucks are running 5 days per week which gives a total of 15 Stag routes and 5 Olympia routes. Although this study has not been completed, preliminary estimates indicate that at least an 8 to 10 percent reduction in mileage will be achieved with one, possibly two or three routes being eliminated.

Three primary differences existed between the analysis of school buses and beer trucks: (1) with beer trucks turnarounds are not a problem, (2) loads are computed differently, and (3) the output results are formatted in a different manner. The beer is packaged in three different types of containers: returnable bottles, cans, and one-way bottles. The trucks are loaded through the use of pallets with a maximum to ten pallets to each truck. The number of cases per pallet depends on the type of container. Thus the capacity depends on the type of container. Thus the capacity constraint that was placed on each truck was 10 pallets. The demand at each stop was given in terms of the number of cases of each type of container.

The change in format of the output results was primarily due to the way the beer is packaged. A comparison of the current and proposed routes is given in Table III.

It is noted that none of the above differences caused any significant conversion to other types of distributors should be even easier.

TABLE III
Comparison of Routes for
DeLeo Distributing Company

	Current	Proposed (Preliminary)
Total delivered (cases/week)	6,644	6,644
Largest load (cases/week)	535	492
Number of trucks	4	4
Number of routes	20	19
Longest route (miles)	206	184
Total miles (yearly)	111,124	100,308

6. CONCLUSIONS

The case studies that have been presented has led us to the conclusion that computerized routing will work. We do not believe that these are extreme cases that have been

presented. Based on what we have done and observing what others have done around the country, an average of 7 to 10 percent savings on each set of routes analyzed is not an unrealistic goal.

For computerized routing to work, there must be cooperation between the customer and the analyst doing the study. If this cooperation does not exist, then it is a futile effort.

In order for the State of Missouri to ever save a significant amount on school bus transportation, the state aid formulas must be revised. The current formulas discourage most schools to reduce transportation cost. It is not true, as some might claim, that formulas that provide an incentive to reduce transportation cost would sacrifice safety and service. It is staggering to think what the savings would be if 7% was eliminated from the more than 42 million dollars that is spent on school bus transportation in Missouri. The responsibility for action on this important subject is upon the state legislators.

7. BIOGRAPHIES

Dr. Byers is an Associate Professor of Computer Science at the University of Missouri - Rolla. He earned a BSME degree and a Ph.D. in Industrial Engineering from the University of Arkansas and a MSE degree from the University of Alabama in Huntsville. He has recently been involved with several routing studies for area schools and companies. He is a member of the American Institute of Industrial Engineers and the Operations Research Society of America.

Dr. Benny Gooden is Superintendent of Schools for the Crawford County R-II School District in Cuba, Missouri. He attended Harding College, Searcy, Arkansas receiving a Bachelor of Arts degree in Music Education in 1966. He attended the University of Arkansas at Fayetteville during subsequent summer sessions and received the Master of Education degree in January of 1969 with a major in Educational Administration. He attended the University of Missouri - Columbia beginning in 1969 and completed requirements for the Doctor of Education degree in 1976.

Dr. Gooden's professional memberships include: the Missouri Association of School Administrators, the National Association of Secondary School Principals, the Missouri Association of School Business Officials, the Missouri State Teachers Association and Phi Delta Kappa.

8. REFERENCES

1. Byers, James K. and Grau, J. Kaye, "Precise Interstop Distances Using a Digitizing Tablet", presented at the 1976 ORSA/TIMS meeting, Miami, Florida.
2. Clark, G. and Wright, J. W., "Scheduling of Vehicles from a Central Depot to a Number of Delivery Points", Operations Research 11, 568-581 (1963).

PEOPLEWARE PROBLEMS IN PLANNING AND IMPLEMENTING
A MANAGEMENT INFORMATION SYSTEM

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Innovation and change in any educational institution can result in personnel unrest and major disruptions. This paper addresses some of the peopleware problems that can result during the process of planning and implementing a management information system. Specific problem areas discussed are: technical problems, conceptual problems, and human relations problems. Methods to prevent or minimize these problems are suggested.

Peter Drucker declared that management is "the organ of society specifically charged with making resources productive."¹ To do this efficiently, the administrator must have accurate and timely information available for decision making. In the past, information was gathered, aggregated and analyzed by available staff or, if this was not possible, approximations would be made. Decisions made based on this information frequently were of low quality. This situation, along with increased reporting requirements and larger educational units, created the need for a more comprehensive and responsive information system. Because of the massive amount of information collected, stored and analyzed by most educational agencies, many information systems are now computer based.

According to Ralph Van Dusseldorp, computerized information systems have progressed through four basic approaches. First was the applications approach, originally used to process fiscal and attendance data. These applications were primarily clerical in nature. Second was the integrated systems approach which was an attempt to integrate the information from various sources. The third approach was the total systems approach which was an effort to avoid duplication in gathering, coding, and processing information. The fourth approach was the management information approach. It was developed to answer criticisms by the administration that information for management planning and decision-making was not being provided.² What is a management information system? A management information system (MIS) is, "...an organized method of providing past, present and projected information relating to

internal operations and external intelligence which supports the planning, control and operational function of an organization by furnishing uniform information in the proper time-frame to assist the decision-maker."³

Central to any data processing system are three significant factors: hardware, software, and people(ware).⁴ This paper discusses some of the peopleware problems that can result during the process of planning and implementing a management information system in an educational agency. Specific problem areas discussed are: technical problems, conceptual problems, and human relations problems. Solution strategies are suggested to prevent or minimize these potential problems.

TECHNICAL PROBLEMS. There are many peopleware problems in planning and implementing a MIS that are technical in nature. Differences in managerial style may require additional flexibility in the system; data of poor quality may reduce the confidence in the system; and fragmented or poorly planned systems may have disappointing results.

MISnamed MIS. Sometimes a computerized system is called a MIS when it is actually functioning at one of Van Dusseldorp's pre-MIS approaches, such as an application approach or an integrated systems approach. These other computerized information systems may be completely adequate for the educational agency they serve, however, they are not a management information system and therefore cannot be expected to function in that capacity.

Other systems are MISnamed as a MIS when they have been poorly designed or are fragmented in nature. In a recent AEDS

Monitor Thomas Richards noted that, "the use of management information systems in public school administration is still in its infancy. The systems in use tend to be fragmented in nature..."⁵ Apparently, educators have some learning and catching-up to do in the area of MIS.

Data Sabotage. If the personnel in an organization misunderstand or resent the implementation of a MIS, data sabotage may occur. Data prepared for the MIS may be intentionally late, altered or omitted. According to Kaimann and Marker: "Without proper preparation, personnel will cause the failure of every system. Whether the difficulties are conscious or subconscious, the result is the same."⁶

Data sabotage is a peopleware problem which can literally destroy any well designed MIS and render it totally ineffective. These potential problems must be continually monitored by the MIS administration and must be solved immediately.

Managerial Styles and Requirements. In a study conducted at Harvard University, it was found that administrative variations in background, management style, and preferences have important implications for an organization's MIS. "To be efficient and effective, a system must both provide administrators with the data they need to handle their responsibilities and be flexible enough to adapt to differing attitudes and priorities."⁷

The manager or administrator of a MIS must not only have a clear conceptual view of the MIS and its interaction with the organization, he or she should have a high intelligence, capabilities of a change agent, and at least an adequate understanding of data processing systems. According to Chris Argyris, "The sophisticated MIS will require of managers a different level of intelligence and conceptual competence."⁸

CONCEPTUAL PROBLEMS. The ability to see the conceptual whole of an organization is desirable for all administrators. This skill is essential in planning and implementing a management information system.

Organizational Changes. The administrator involved in planning a management information system must have a clear picture of the organization and its goals. He or she should also be well acquainted with the personnel and their characteristics.

Frequently, the implementation of a MIS requires significant policy and organizational changes. If these changes are not

made, duplication of effort as well as personnel unrest may occur.

MISconceptions. Frequently, when a management information system is introduced into an educational agency, a common feature occurs. Many administrators are unrealistic about the system's limitations and capabilities and therefore develop unrealistic expectations. This can be the result of misconceptions about the MIS or the result of an over-zealous sales pitch.⁹

In a study investigating the administrative reactions to computer based information systems implemented in several universities, it was found that many administrators expected the information system to be a panacea for their administrative ills. It was also found that the less quantitative, less computer oriented administrators felt that the proposed system would cure many of their financial problems.¹⁰

HUMAN RELATIONS PROBLEMS. Innovation or change in any organization may cause disruption in the institutional routines and personnel unrest. The implementation of a MIS may cause some administrators to gain power while others lose power. These peopleware factors may cause human relations problems.

Managerial Unrest. Many administrators, even those who have a clear conceptual and technical view of the MIS, may feel unrest when a MIS is initially implemented. They may feel that the MIS threatens their power and autonomy. In the study previously cited, some administrators felt that a centralized information system implied centralized administration.¹¹ This is not necessarily true.

Those administrators who mistrust a MIS may use MISconceptions about a MIS to support their biases. Effective communication, trust and openness are essential to the successful planning and implementation of a MIS in an educational agency.

Personnel Unrest. During any organizational change, personnel at the middle and lower levels of the hierarchy usually experience the most dramatic change. Daily habits are frequently altered and they must learn new techniques or routines. Work loads are sometimes uneven at first and emotions are high.

Personnel at all levels should be informed about the MIS, and any changes expected or required. Organization changes should be made at the administrative level with input from personnel at all levels. If the personnel are not informed and at least partially in favor of the change, the system will fail. Bad data, late

reports, and other system sabotage are the frequent culprits of a MIS failure. People, machines, and a system must be combined into a smoothly functioning person-machine interchange within the MIS. The people barrier must be a barrier of major concern for the administrator.¹²

SOLUTION STRATEGIES. The major solution strategy suggested in this paper involves the use of an organizational change model. Several other suggestions are also offered such as management training, and allowing adequate time for the implementation of the MIS. The following Table is a summarization of the problem and solution strategies.

TABLE

Potential Problem and Solution Strategies in Planning and Implementing a MIS

Problems	Solutions
Technical Problems MIS named MIS Data sabotage Managerial styles and requirements	Professional MIS expertise plus management and personnel training.
Conceptual Problems Organizational changes MIS conceptions	Organizational change model plus management training.
Human Relations Problems Managerial unrest Personnel unrest	Organizational change model plus adequate planning and time.

Organizational Change Model. The planning and implementation of a management information system in an educational agency will be more effective if the administrator uses an organizational change model. The model selected and adapted for this situation is "Coleman's Model for Accomplishing Change." It was developed at the University of the Pacific, Stockton, California by Dr. Thomas C. Coleman. The steps are:

1. Exhibit a transactional leadership model utilizing a democratic leadership style which provides an environment supporting openness and encourages innovation.
2. Identify data needs and data flow through a needs assessment process.
3. Develop a mission statement. That is, state the purpose and function of the management information system. Translate the needs into measurable goals and objectives (output of the system).
4. Identify the constraints and considerations such as: financial, facility, personnel, legal, traditional, philosophical, etc.
5. Create the awareness for change; gather support for the MIS; create interest in MIS; develop a solid relationship between the change agent and the

educational agency.

6. Develop alternative MIS models. Consider many ideas. Involve personnel at many administrative levels and especially top management.

7. Compare and evaluate the identified alternatives based on criteria such as efficiency, effectiveness, constraints, time, etc.

8. Select the best alternative for your situation.

9. Develop diffusion strategy. Tell by communication; show by demonstration and observation of other MIS; help from consultants with MIS expertise; involve all affected; train through orientation, workshops, group meetings; reduce anxiety

by sensitivity groups, new job descriptions and responsibilities. Gain acceptance. Mobilize for change.

10. Pilot test the MIS in one part of the educational agency. Involve those at all levels. Arrange for the remainder of the agency to observe the process and talk to the participants.

11. Evaluate the pilot test in terms of effectiveness in meeting MIS and the organizational goals and objectives; modify as necessary.

12. Adopt and implement in the entire educational agency. Use diffusion strategies identified in step 9.

13. Monitor, supervise and follow-up carefully.

14. Restore balance to organizational structure; stabilize and restore security; eliminate anxiety.¹³

If the above change model is used in planning and implementing a management information system, many of the potential peopleware problems will be prevented or minimized. A carefully conducted needs assessment on information needs and data flow will ensure that the MIS developed will be effective. Appropriate diffusion strategies and pilot testing will function to prevent many technical, conceptual, and human relations problems. When

people understand what is happening and know what to expect in the future, they will adapt more rapidly to the change and have fewer MISconceptions.¹⁴ If they are consulted at various stages of the planning and implementation process, they will be more supportive of the MIS and less sabotage will occur.

Management and Personnel Training. Some management training on MIS is desirable in any organization prior to the planning and implementation stage. If the administrators are well informed about what is possible with a MIS, they will be better prepared to provide meaningful input and leadership to the development of a MIS. After the MIS is planned, all management and personnel should receive information on the change process to be used as well as on the details of the MIS.

Training for management and personnel should be provided periodically on the proper use of the MIS. Appropriate usage of the MIS is crucial to its success, effectiveness, and continued existence.

Adequate Planning and Time. Adequate and careful planning is critical to the ultimate success of a MIS. Personnel from all levels should be involved as well as top management. The success of a MIS frequently rests on details that are easily overlooked.

Change requires time to become effective. A temporary reduction in productivity should be anticipated during the implementation stage. Personnel must adjust and sometimes be retrained. Resistance to change is not always the result of stubbornness. Overloading may be a factor.¹⁵ Adequate planning and time are necessary to avoid these situations.

SUMMARY. Peopleware problems in planning and implementing a management information system fall into three major areas: technical, conceptual, and human relations. Most of these problems may be prevented or reduced by the proper use of an organizational change model. Also, management and personnel training will facilitate the implementation of the management information system. Careful planning must be done to ensure the effectiveness of the resulting system.

When a management information system is appropriate, the planning and implementation of the system must address peopleware problems. As peopleware problems are minimized, the true potential of the management information system can be realized.

FOOTNOTES

¹Peter F. Drucker, The Practice of Management (New York: Harper & Row, 1954), p. III.

²Ralph Van Dusseldorp, "Management Responsibility for Information Systems," Educational Technology, XI (May, 1971), 38-39.

³Walter M. Mathews and others, Management Information Systems: The State of the Art, U.S., Educational Resource Information Center, ERIC Document ED 090 692, November, 1972.

⁴Richard A. Kaimann and Robert W. Marker, Educational Data Processing: New Dimensions and Prospects (Boston: Houghton Mifflin Company, 1967), p. 16.

⁵Thomas C. Richards, "A Mini Management Information System for Public School Administration," AEDS Monitor, XIV (April/May/June, 1976), 5.

⁶Kaimann and Marker, p. 16.

⁷Joe B. Wyatt and Sally Zeckhauser, "University Executives and Management Information: A Tenuous Relationship," Educational Record, LVI (Summer, 1975), 175.

⁸Chris Argyris, "Management Information Systems: The Challenge to Rationality and Emotionality," Management Science, XVII (February, 1971), B280.

⁹Wyatt and Zeckhauser, p. 181.

¹⁰Wyatt and Zeckhauser, p. 181.

¹¹Wyatt and Zeckhauser, p. 181.

¹²Kaimann and Marker, p. 16.

¹³Thomas C. Coleman, "Coleman's Model for Accomplishing Change," developed at the University of the Pacific, Stockton, California, November 1975.

¹⁴Stephen J. Knezevich, Administration of Public Education (New York: Harper & Row, 1975), p. 101.

¹⁵Knezevich, p. 103.

WIJET

(Wayne Intermediate Job Entry Transmitter)

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ABSTRACT: Wayne County Intermediate School District has developed a computer system consisting of both large (IBM 370/158) and small (HP 2000) computers linked together allowing users the benefits of the large "number cruncher" with equally large disc storage along with a mini-computer with excellent interactive capabilities. This paper deals with why such a system was developed, the problems encountered, the final successes, how it is used, its advantages, and its future.

Background

Within Michigan there are 598 local school districts divided into 58 regions called "Intermediate School Districts" in that they are intermediate between the local boards of education and the State Board of Education. Wayne County Intermediate School District serves 36 local school districts in the Detroit area with a combined total of almost 600,000 students. In many ways it acts as a service bureau to its member districts by offering them services they could not afford themselves such as special consultants, large meeting spaces, a professional resource center, a print shop, and data processing.

History

Wayne County Intermediate School District has been offering computer services to its 36 constituent districts since December 1973 when it obtained its first computer---an IBM 370/158. Currently 29 districts make use of these facilities by means of remote terminals and telecommunications. Users do not bring cards in nor do they receive printouts at the Data Center, but enter and receive data using their own IBM 3780 type terminal located in their own Board of Education Office. Using this method, WCISD currently processes over 1100 job-streams per day.

In September 1975 instructional computer timesharing was offered to the member districts for the first time. Three districts with 21 terminals, mostly teletypes, decided to avail themselves of this service. Since the desire was to offer the best service possible, the operating system picked was VM/370 (Virtual Machine) from IBM. Through VM each student thought he had his own IBM

370/158 computer. This meant that students could write programs in just about any language as well as stop their machine, interrogate various variables, and even replace systems modules with their own without having any effect on other users.

By October 1975 it had become apparent that VM was not the solution. While it is an excellent product, most students found the commands too confusing and it wasn't easy for a student to create a program on one terminal and then go to another to modify or execute it. To solve these problems procedures and systems modules were created. The sum total of all of the modifications made to the student system, the fact that it was also being used by people within the office for problem development, and the increasing amount of batch jobs being run meant that the time needed to retrieve a program from disc storage or to replace it could be significant. There had to be a better way. Tuning VM produced a slight improvement; re-writing most of the commands used by the students gave another slight improvement; and even stealing more computer cycles from the batch machine, which disturbed the batch users even more, were all tried. The only solution seemed to be to find another operating system or get another computer. MUSIC from McGill University was investigated and found that, while it would improve the time sharing response, batch would probably suffer. The only hope left was to go to a second computer and leave the first one for batch without VM.

Should this second computer be a large machine so that it had the capabilities of many users and many languages or should it be a small one with limited languages and users? Even though the use of the

computer services in Wayne County had grown faster than anticipated, it didn't seem reasonable to get another multi-million dollar computer. Yet a small computer may not be able to offer the languages and capabilities that were already being offered.

Many mini-computer vendors claimed their system could be used for the BASIC language and then "magically" use the IBM for the other languages. Only one known vendor (Hewlett Packard) had already developed the hardware and software that would allow their mini to be used as the computer for those that wished to use BASIC and as a HASP multi-leaving work station for those wishing to use other languages. Because of this inter-computer ability, a Hewlett Packard 2000 computer system was ordered. It arrived 26 February 1976 and was up and running the next day, except for the link.

Those BASIC language only users moved to the HP immediately. They found the response time to be practically instantaneous. Since the link had not been tested, it was felt unwise to move the other users to the HP at this time and so they stayed with VM on the IBM until Summer. They too found response time greatly improved since VM was now only handling 5 machines instead of 25.

With minor difficulty the link between the HP and IBM computers was established and then the software package developed by HP to support the link was tried. Besides being very cumbersome for the user in the number of questions asked before anything was transmitted, it required an excessive number of computer ports—one for each function wished to be supported simultaneously. Since a HASP multi-leaving work station could handle 7 printers, 7 punches, and 7 card readers along with a console simultaneously, up to 22 of the 32 ports could be dedicated to these functions. Even its minimum configuration (one reader, printer, and console) would require 3 ports. This was a luxury WCISD could not afford and so a separate package, WIJET, was developed.

WIJET and EDIT

WIJET (Wayne Intermediate Job Entry Transmitter) was developed to make use of the hardware connecting the HP and IBM computers, to use only one port on the HP side, to act alternately as a reader, printer, and console, and to require minimal modifications on the IBM side. WIJET has been in constant use since September 1976 and moves upwards of 200 job-streams per day back and forth between the two computers.

WIJET together with EDIT allows a user to:

1. create and modify his program and data
2. transmit it to the IBM for execution
3. inquire as to the status of his job

4. receive output back in a designated file
5. store and retrieve files from the IBM

When a user wishes to create or modify an existing program or data file on the HP, the program EDIT is executed as shown in figure 1 below. EDIT asks the name of the file and the file type if it is a new file. This file type is used to set various parameters such as the tab stops, lower to upper case translation, and source line length. In the case shown below WATFIV or FORTRAN would have a tab at column 7, would change everything to upper case, and would not allow anything inputted past column 72. For WATBOL or COBOL the tabs would be at 8, 12, 16, etc. and for ASSEMBLER the normal truncation would take place at column 71. Since the example shown pertains to a new file, the user would most likely immediately go to the INPUT mode, but could change some of the preset parameters or get parts of another file to work upon. Once the entire file has been entered, the user would leave the INPUT mode, probably return the file pointer to the top of the file, and list its contents.

The user can now check for errors and when he is sure that it is correct, save it on the HP and send a copy to the IBM via the program JETSCH or by issuing the command SEND while in the EDIT mode. At this time WIJET takes over by checking the legality of the user and the file and then by asking the user where the output is to be placed. (See Figure 2 below.) If the

```
-----
EXE-EDIT
EDIT

FILENAME? DEMO
NEW FILE

FILETYPE? WATFIV
E:INPUT
>$JOB
>!DO 10 I=1,10
>  10 PRINT,I,I*1
>!STOP
>!END
>$ENTRY
>
E:TYPE *
to:
$JOB
    DO 10 I=1,10
    10 PRINT,I,I*1
    STOP
    END
$ENTRY
eof:
```

Note: All data entered by the user is underlined. The exclamation point (!) represents the tab key.

Figure 1.

user and file pass all the tests, the job is given an HP job number and data about the job is placed within a job queue. The user is now free to work on any other program or file or to monitor his job through the IBM.

This monitoring takes place through the program JETQ which asks the user his HP job number and then tells him the status of his job which could be one of the following:

1. waiting to be sent to the IBM
2. was sent to the IBM
3. was sent as HASP job 1234
4. had an error reading the source
5. has been returned
6. had an error returning the output
7. contained illegal JCL

JETOUT is used to print the output on the user's terminal when it has been returned. The options within JETOUT include whether the printout is to appear as from a normal printer (with large gaps of paper and maybe only one or two lines per page) or in a compressed form, whether the HASP job statistics are to be printed, and on which page of the printout it is to begin.

The user now corrects any errors and submits the job again to the IBM for execution.

Note that in Figure 1 above, there was no JCL (Job Control Language) supplied nor is it required because WIJET detected the lack of any and included the standard set appropriate to the specified file type. Thus a user does not need to learn or to worry about anything except the way to use the system and the language he is currently using.

Internal Operations

WIJET operates by having a directory of all of the legal user accounts and all of their passwords. A given account may have more than one password which allows several classes of users within that same account. For example: one password could be given to a group of students allowing them the use of only WATFIV and WATBOL, another password could allow other students these languages and PL/I, and the teacher with still another password may have the capability of generating his own JCL including routing the output to an IBM 3780 type terminal. When a user executes any of the JET programs this directory is checked to see if the user is legal and what capabilities he has.

Once the user and his password have been located in the directory an entry is made in the job queue file of the user's

```

E:SEND
PASSWORD?          (not printed)
OUTPUT FILE?OUTPUT
JOB HP-129 SCHEDULED
DONE

```

Figure 2.

account and password number, the name of the source and output files to be used, the file type of the source, the number given it by the HP, what is to be done with the file, and spaces for the HASP number and a completion code. The only questions asked of the user are those which cannot be obtained from the file and/or EDIT as well as his password.

A terminal located near the computer in the WCISD Data Center runs a program whenever the WIJET link is active. This program continually monitors the job queue file, the message queue file, the link to the IBM, as well as its own keyboard. Every ten seconds it makes a check of each element and if it finds anything new it takes care of it. When an entry shows up in the job queue file it reads it and then accesses the specified source file. This data, together with the appropriate JCL (if required), is then sent to the IBM. Material back from the IBM, including the HASP job number and the actual output, are cross-referenced with the job queue file and sent to the actual user. All unrequested messages are displayed on the console and all unrequested output files are stored for later inspection.

Other Parts of WIJET.

One of the other capabilities of WIJET makes use of a program on the IBM which allows users to store and then later retrieve files from the IBM. This was done because of the large amount of disc storage available on the IBM and the relatively small amount on the HP---currently 3.7 billion versus 15 million bytes. JETPUT, which transfers a file to the IBM for storage, asks the user the name to be used on the IBM, who is allowed to access it, and what his initials are. At a later date he can use JETLIB to find out what he has stored, when it was stored, as well as other data about the file. JETGET would then retrieve it back to the HP where it could be used again or modified. JETREP and JETSCR are used to replace files on the IBM and erase them respectively.

Since a program and its data file are quite often created and stored separately, WIJET allows a user to refer to other files to be included within a job stream through the use of an @@@ statement. This informs WIJET that, starting now, data is to be sent from a second file and when that one, with its @@@ statements (if any) is completed, continue with the next line in the current file. Figure 3 below shows three files and what would be sent to the IBM when SAMPLE is specified.

WIJET also allows either the source or the data to be taken from a file on the HP while the other is taken from the saved library on the IBM. This is particularly useful when a standard program is being run against new data created on the HP or when a teacher wants to hide the test data for a particular assignment.

Other Parts of EDIT

Besides setting up different attributes, depending upon the file type specified, EDIT allows these attributes to be changed for the current session. There is also the capability to set up a file containing a set of EDIT commands and then execute that file, causing those commands to be invoked. EDIT is a context editor, so it is possible to change part of a line or lines without having to re-enter the entire line. EDIT will also locate or "not-locate" a specific text anywhere within the file or between specific columns.

One particularly useful EDIT command is the SET command which allows the user to cause a particular symbol to be translated upon input to another symbol or symbols. For example, Figure 1 above used the exclamation point (!) to represent the tab character. If there was no tab button on the terminal being used and if "!" was not going to be used with the text, the following statement could be entered

```
SET ! '9
```

which would cause the "!" to be translated to the ninth ASCII character which is the tab character. The SET can also be used to translate one character to several. For example, the sequence "tab" followed by "FORMAT (" is quite often used in FORTRAN. Another unused character could be set as follows:

```
SET ? "IFORMAT ("
```

the file SAMPLE:

```
$JOB
$$$F,PROG
$ENTRY
$$$F,DATA
$STOP
```

the file PROG:

```
C SAMPLE PROGRAM (WATFIV)
  READ (5,10) J,K
  10  FORMAT (213)
     DO 20 I=J,K
  20  WRITE (6,30) I,I*1
  30  FORMAT (2110)
     STOP
     END
```

the file DATA:

```
001010
```

what would actually be sent when SAMPLE was specified:

```
$JOB
C SAMPLE PROGRAM (WATFIV)
  READ (5,10) J,K
  10  FORMAT (213)
     DO 20 I=J,K
  20  WRITE (6,30) I,I*1
  30  FORMAT (2110)
     STOP
     END
$ENTRY
001010
$STOP
```

Figure 3.

Then by typing

```
100?215)
```

EDIT would translate it to read

```
100  FORMAT (215)
```

Since EDIT was designed to create programs on the HP (which uses ASCII) for execution on the IBM (which used EBCDIC), both ASCII and EBCDIC character representations are legal to use in many EDIT commands. For example:

```
SET ! '9
```

```
SET ! 0B
```

both set the "!" so that upon input it is translated to "vertical tab". Similarly

```
SET @ '50
```

```
SET @ F2
```

```
SET @ "2"
```

all cause "@" to be translated to the number 2. This allows the use of all 256 EBCDIC characters, some of which are not available within ASCII, but are available on the TN print chain used on some IBM printers. These special characters include superscript numbers (80-89), the bullet (AF), the box (9F), and the lozenge (9C).

Since it is possible to route output to the IBM printer using the TN print chain, EDIT together with WISP (Wayne Intermediate Script Processor) allows users the capability to use the system as a word processing machine. In this way WCISD has produced manuals as well as newsletters and personalized form letters.

Future Plans

The HP computer is currently servicing about 40 terminals in 8 districts and WIJET is running well on over half of them. Student jobs and those that pertain to the IBM-HP Library are given special execution priority. Output from execution is usually returned to the student within 3 minutes of submission.

The only problems with WIJET are that when it was designed, there were very few users and response to an EDIT command was very fast. Currently there are so many users on the system all trying to access the single 15 million byte disc, that the HP computer appears to be disc-seek bound. Response has again decreased to such a point that another EDITor will have to be developed with less disc activity. Another problem is that WIJET requires a separate output file for each job sent and these, together with the work files needed by EDIT, produce a very heavy load on disc space. To alleviate this problem, WIJET is to be re-written so that all output from the IBM is returned to one common file containing a catalog of entries. When a user wishes to have his output printed, it would be located within this catalog, printed, and then the space freed after moving a copy to the user's ID if requested.

Because of the increased number of users on the system, another HP 2000 computer has been ordered and should be delivered about 1 March 1977.

MANAGING COMPUTERS AND COMPUTING

Post Secondary & Higher Education

A LITTLE BIT OF KNOWLEDGE FOR
THOSE WHO BYTE THE BULLET

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A frequently overlooked managerial responsibility, providing on-going training for professional staff members, is discussed. Factors affecting the problem are enumerated. Subtle techniques for providing for staff education are described.

Today, educational institutions must look to their data processing enterprise to resolve the ever-growing, cumbersome, and complex problems posed by administration. The technical staff within the data processing enterprise performs the vital task of working with management to bridge the gap between administrative goals and the computer, with problem solving as their fundamental objective. The majority of problems encountered by the technical staff are resolved by a process that involves analysis of the ramifications of the problem, evaluation of alternative solutions, selection of the best solution method, creation of new software, or making new hardware (which is called for by the selected solution method) functional. While this process has shown proven results, its effectiveness is frequently inhibited by an important and often overlooked factor: the programming-analytical staff approaches the solution process from the standpoint of the status quo relying exclusively upon their present knowledge. That knowledge, however, may not be sufficient to cope with a changing environment. Too few managers realize that their technical staff may not be equipped to efficiently copy with new projects until very late in the process or, tragically, until irrevocable commitments have been made. These commitments, if unfulfilled, can produce embarrassment for the data processing manager, his staff, and perhaps, his institution. Thus, it behooves the manager to develop the means to assure that his staff is constantly up-to-date with the knowledge they need to solve problems. The development of such means can be accomplished at a relatively small cost if the problem of providing knowledge is understood, the need for staff education is recognized, and if prevailing practices, which relate to the availability and dissemination of

information to the technicians, are examined and modified.

There are several circumstances that could lead the manager to erroneously conclude that it is not necessary to attend to the educational needs of his professional staff. Foremost among these is the situation where an institution has sufficient financial resources available to hire newly-needed technical expertise on either a long, or short-term basis. The prevailing state of educational economics, however, is such that most institutions no longer have ready cash available to shore up staff deficiencies, and for those that do, acquiring the cash can be a grueling and prestige sacrificing adventure for the manager requesting it. Thus, it is far more desirable, and in most cases, necessary, to provide for the education of current staff.

Another circumstance which contributes to inattention to staff training is the prevalent status of staff activities. There seldom seems to be enough time to free staff from on-going activities to allow them to become familiar with the knowledge they will require in the future (clearly, the manager must define what that knowledge is). In addition, even if the required knowledge is defined, it is usually incompatible with the existing software/hardware; hence, the knowledge cannot be immediately applied since application takes time and time is at a premium. Although the immediate productivity of the technical staff is somewhat lessened, the future benefits derived from a staff possessing enhanced knowledge will more than compensate for the time spent in staff education.

A third reason for neglecting staff education is the fallacious assumption that if new expertise is required, exist-

ing staff can undergo intensive training when needed, to acquire it. This assumption is premised on several factors: First, that the leadership of the institution will tolerate a delay in the delivery of the solution while the staff is undergoing training. While most higher-level administrators may be convinced that the training period is reasonable, the nature of academic decision making is usually such that problems are presented to the data processing department on a random basis. This can create fluctuating priorities for data processing and interrupts, or ends, the training program for the problem formerly designated as top priority. A second factor is that the appropriate training required by the staff will be available when needed. However, while facilities for training are widely available, the need for particular bodies of knowledge is rarely synchronized with the offerings. The third factor, the receptivity of the typical programming analytical staff to training is, perhaps, the most disturbing facet of the problem. While all professional staffs are not identical, they are similar in that each is basically a collection of people, each with his own strengths and weaknesses, and each of whom possesses, or possesses, a talent essential to the mission of the department at a particular time. What conclusions can be drawn that indicate why such people might not be receptive to training? First, educational institutions experience great difficulty in attracting and retaining top quality technicians. Salaries for educational technicians usually are not comparable with industry; thus, aside from the aesthetic features, there are few incentives to become a programmer or analyst in education. Second, few, if any, institutions have career development paths for technical people; thus, there is little reward for achieving the excellence which is normally associated with such advancement. Third, the professional staff is commonly a highly polarized body with one or two highly machine-oriented individuals on one hand, two or more problem-oriented people on the other, and a great chasm of technical proficiency between them. The problem-oriented people tend to become reliant upon the machine-oriented people for technical expertise. To the extent that mutual cooperation produces results, this is desirable; however, in many cases, the problem-man may lose his incentive to gain more technical expertise and in doing so, becomes a liability. Therefore, the manager must not only plan and implement a constructive education training program, he must also stress the importance and validity of keeping abreast with the knowledge needed to produce results.

Regardless of the function that a staff member must perform, the knowledge

needed to perform a function is always a combination of technical and environmental factors. The programmer in education must be aware of the capabilities of the hardware he is working with and should possess a detailed knowledge of software features and techniques. The analyst must also have mastered hardware concepts and should possess a detailed knowledge of the advantages and disadvantages of both software and hardware features. Beyond the technical knowledge, it is imperative that both programmers and analysts know about the institution's organization, goals and objectives, broad problems, limitations, policies and lines of authority and responsibility, as well as the department's standards, reporting requirements, and resource availability.

For example, if the development of a system was proposed, reviewed, approved and implemented, then at some point the programming-analytical staff would require the knowledge to cope with questions like the following:

- How will this system contribute to reaching institutional goals?
 - Will this system lead to the development of other new applications?
 - How will this system relate to other systems?
 - Can the development of this system be used as an incentive to remedy known deficiencies in other systems?
 - Are there sufficient people and hardware resources available to support this system?
 - Are there any legal, audit, regulatory, or policy considerations to contend with?
 - Who may have access to the data within the system and in what form?
 - Must system or program flowcharts be produced?
 - What computer language can be used and what programming conventions must be used?
 - Must progress reports be prepared during development?
 - When is machine time going to be available to compile and test?
- The list is seemingly endless; yet, each question falls within the domain of either technical or institutional knowledge and each must be coped with to successfully complete the project.

To successfully provide the professional staff with required knowledge, the manager must first make a commitment to do so, and then sell the concept to upper management. Even the simplest of in-house training programs requires that some of the resources of the data processing department (time, people, and dollars) be directed inward rather than outward. Resources reserved for staff training must be justified to upper management or the resources will be infringed upon and the training program will be ineffective. The second vital step in the process is to ensure that professional staff members are made aware that their development is a sanctioned departmental activity holding as high a priority as any other activity. Failure to communicate this will, again, result in a meaningless exercise. The third, and last, preparatory step is to advise the user departments of the training to occur, that it is blessed by upper management, and that whenever possible, the training of the data processing personnel will be transparent to the user departments in terms of the data processing department's productivity.

While each of the preparatory steps is vital, the last step regarding user departments has a special significance. The goal of the training to be undertaken is to maintain professional staff competence on both a technical and institutional level. While user departments are not technically oriented, their contribution of institutional knowledge to the data processing department is imperative since the data processing people are responsible only for assuring the technical feasibility of decisions made by the user departments.

An important part of any educational program is the determination and selection of those sources of information which will be most beneficial to the particular institution's needs. During this selection phase it is important that the manager be concerned with knowledge for the entire staff, not selected individuals. Whatever media is selected for whatever audience, the information learned must be shared. To accomplish this, individual staff members who acquire new knowledge should present it to the entire staff for discussion. The manager should also be a participant in such discussions as there are numerous instances, particularly in the area of institutional knowledge such as new policies, organizational changes, etc., where the manager is the initial learner.

Sources of technical and institutional knowledge can be divided into three large categories: publications, presentations, and field trips. Each of these

categories has a different set of circumstances imposed by prevailing practices which limit its effectiveness as a learning tool. What are these circumstances and what can the manager do about them?

Publications comprise the most readily available source of knowledge. Yet, in practice, publications available to the professional staff are usually limited to technical books, magazines and newspapers and institutionally generated catalogs, brochures, and procedures documentation. Technical materials generated externally (Computerworld, Datamation, etc.) normally arrive at the manager's office where the manager reviews the contents looking for relevant material and, if such material is encountered, routes the publication to the staff. Documents generated externally, which contain institutional type information (The Chronicle, journals, etc.), normally arrive at the manager's office where they are reviewed and librated for future reference. This form of censorship deprives the technical staff members of an opportunity to expand their horizons. A more meaningful practice would be for the manager to reserve a block of time for staff to review publications, and to systematically route both technical and institutional type materials to the entire staff with an annotation as to the date that the material will be discussed. It may be desirable to periodically disrupt the normal routing to allow staff members with particular interests to review the materials and prepare to lead a scheduled discussion.

Publications generated by the institution itself (bulletins, catalogs, etc.) are usually available to each staff member. The standard practice is for the department secretary to be the recipient of such materials for distribution to the staff. Typically, staff members replace their old editions with the new editions without perusing them. Again, a better practice is to assign a discussion date to any new knowledge and to then discuss it on that date. Such materials can be of immeasurable value in indoctrinating new hires, yet typically they do not receive the materials until the next editions are distributed. A better alternative is for the manager to retain a full set of such publications, particularly for use by new hires, to afford them an opportunity to become familiar with their new environment.

A particular brand of institutionally generated publications, which rank as the foremost tools of the programmer's and analyst's trade, are: the data processing department's procedures and standards manual, the documentation of existing systems and programs, and the procedures manuals of user departments. Typically,

these materials either do not exist or are of dubious quality. However, the creation of adequate institutional documentation should be a fundamental goal of the institution's system development entity, whether that entity is associated with the data processing department, research department, operations group, or information systems group, and is a goal of higher administration regardless of the mechanism for enabling its creation. The DP manager should assume a leadership role in the creation of effective documentation standards. In most shops, the professionals themselves are responsible for generating documentation and ensuring that it is distributed. A better practice is to appoint one individual to review and distribute all documentation thus ensuring the integrity of this vital bank of knowledge.

Presentations, be they by cassette vendor representatives or local technical experts from professional associations, are the most common form of education and the source of knowledge which attracts the largest audience. Typically, they too are ineffective and leave the professional staff members cold. But, the manager can take steps to improve them. As mentioned earlier, some of the reasons for the ineffectiveness of presentations are that the material presented is seldom applicable to the professional staff's present environment and they are not afforded an opportunity to experiment with the new concepts learned. However, a more significant negative aspect of presentations is that the audience is usually not confined to just one institution's technical staff; hence, questions unique to the institution are not asked. To be effective, presentations should be limited to the programming analytical staff and affected users of a single institution. The attendees will then have an opportunity to discuss the issue with the presenter in an uninhibited way. In addition, a means must be available to observe the topic of the presentation in action, and a follow-up session should be convened to discuss the applicability to the institution of the concepts presented.

Field trips, conference attendance, and visits to other installations, are the most infrequent educational experiences available to the professional staff. As the composition of most conferences and conventions attests, the attendees at such experiences are usually the data processing manager or one or two of his most proficient aides. The same is true of single day visits to other installations and professional organization meetings. The selection of attendees to professional meetings is influenced by two key factors: First, the manager and his most valued employees may be the only staff who are

members of the organization hosting the session; Second, the manager may have limited money available for travel, hence he sends his best people on the premise that his institution will derive the most benefit from that individual having attended. Seldom is the effect upon those staff members who did not attend considered. To them, a chance to travel is perceived as a reward given to the chosen. This perception can be changed simply by identifying events which are worthy of institutional participation, budgeting to accommodate attendance, and rotating attendees among all the professional staff. Should membership in a particular organization prove to be an obstacle for the participation of some of the staff members, the institution should be prepared to provide funds to remove that obstacle.

In addition to publications, presentations, and field trips, a most effective means of enhancing a professional staff member's understanding of the environment that presents problems to be solved is to involve the staff member in the activities of the various user offices. This can occur as subtly as lending the entire professional staff to operating units during periods of extreme workload, or by locating professional staff offices in user areas. It can also occur as dramatically as relieving the technicians of normal responsibilities for a period of time during which they work in a user department doing their non-data processing tasks. Data processing managers are particularly reluctant to provide such experience for their technical staff. There is a fear that the data processing department will come to be viewed as an excess labor pool by other managers who have not planned adequately. However, if such experiences are arranged within the context of a formal educational program as described previously, and if arrangements specify the time period and assignment nature, then, the traditional reservations and fears are dispelled.

In summary, attending to the educational needs of his professional staff is of vital concern to the data processing manager if his department is to address institutional problems in a meaningful way. Learning activities need not, and will not, seriously disrupt departmental productivity as increasing exposure to knowledge can be accomplished with relative ease by modifying existing practices. Quite the contrary, providing a little bit of knowledge to those who 'bite the bullet' can only result in a more efficient, effective and functional organization.

A SIMULATION MODEL OF A NATIONAL NETWORK
FOR EDUCATION AND RESEARCH*

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Abstract

Computer networking has often been mentioned as an attractive means for providing educational and research institutions with access to a wide variety of computing services. Although such a network is technically feasible today, its economic, political, and organizational implications have not been established.

A computer simulation model has been developed to investigate such behavioral aspects. This paper discusses the overall design of the simulation model and the issues to be studied using this model.

Introduction

Decision makers at educational and research institutions are grappling with difficult questions about how best to satisfy the expanding and increasingly varied demands for computing services. Although user demands will continue to grow, the cost spiral must be controlled. Technological advances in microcomputers, minicomputers, and large-scale hardware facilities will not, in themselves, be sufficient to satisfy the requirements for economical access to a rich variety of computing services.

Networks offer a very attractive means for improving the efficiency and effectiveness of computing. (1) A consensus exists that it is technically feasible to create a network of computer facilities at colleges, universities, and research institutions around the country. Although some technological problems remain, the primary difficulties confronting such a network are viewed as being nontechnical in nature. (2) In particular, economic, political, and organizational factors are considered likely to pace the development of a successful network.

In order to deal with these issues, it is necessary to have a clear understanding of the potentials, limitations, and implications of networking.

Objectives

Existing networks do not have the characteristics necessary to serve as a basis for investigating these concerns, and analytical techniques are inadequate in such a complex environment. Consequently, a simulation approach has been adopted as a mechanism for conducting the required research.

Assessing the implications of a national network for higher education is an important and complex problem. The economic and educational consequences of a widely-used network would be considerable. In order to provide valid guidelines, a study of networks must deal with a large variety of technical, economic, and administrative issues. Given the importance and magnitude of the problem, the National Science Foundation is supporting a major study by EDUCOM** to examine the likely implications of networking for higher education. The three-year study will

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**EDUCOM is a consortium of more than 250 colleges, universities, and non-profit organizations that serve higher education. It was founded to help its members make more effective use of computer and communications technology.

be completed approximately June, 1978.

Two primary objectives were established for the project. The first objective is to explore the parameters that govern network behavior and to isolate and examine those elements critical to network success or failure. The second objective is to provide assistance to institutional decision-makers in understanding the impact that a national network could have upon internal resource allocation.

The first objective requires investigation of policy and structural issues associated with a network. Policy issues include pricing, funds flow, network standards, service guarantees, user support, marketing, and capacity adjustment responses. Management structures can range from a loose set of bilateral agreements between individual institutions to a highly structured and centrally managed network. Each policy alternative must be examined in light of the various feasible network structures.

The second objective of the study is to improve institutional decision-making ability relative to policies pertaining to national networks. Some of the data already collected indicate that institution administrators often do not have sufficient experience with networks to establish clear policies governing network situations. Even where explicit policies exist, they are often incomplete or inconsistent and may contain unanticipated implications for the institution or the network.

The results of the investigations should clarify for administrators the present intuition-based conceptions about the impact of their policy decisions. This study should also aid them in assessing the probable advantages and disadvantages of various modes of network participation.

Simulation Approach

Existing networks can provide an indication of the costs and technical characteristics of a national network. They do not indicate, however, how a dynamic national networking environment would affect member institutions. Neither can they be of much help in assessing how the effects would vary with the particular computing philosophy, policies, and practices of each institution. For example, what changes would a network bring to instruction, research, science information, or administrative computing? What would be the impact of "balance of payments" problems? How would users be affected by the availability of multiple

resources at a variety of prices? What changes would take place in the types of computing resources developed or maintained by an institution? What impact would a network have on established institutional policies? These are critical issues, and existing experience provides little insight in dealing with them.

These questions can best be examined in an environment in which the implications of such policy questions can be observed in concrete terms. Moreover, that environment should be free from constraint by a priori solutions to these issues so that aspects of network management and control can be subject to experiment and change.

No existing network has the necessary characteristics to serve as an adequate basis for explaining all of these issues. Even if such a network were available, using it to examine these issues, while providing concrete results, would pose a number of problems. Experimentation would be extremely costly, disruptive, time consuming, and limited in the number and scope of alternatives that could be investigated.

In recognition of these difficulties, a simulation approach was adopted. The model that has been developed is highly parameterized and flexible, and it permits the examination of network policy rules under different network configurations, management structures, usage modes, and growth patterns. In addition to technical information describing local hardware, software, and usage, the data associated with each network node contains the policy specifications and decision rules necessary to dynamically represent site behavior under evolving network conditions.

For purposes of design, the model network has been defined as having twenty initial sites. Eighteen of these have been reserved for detailed representations of the eighteen institutions participating in the project. (The actual number of sites to be used in any given run is, of course, an input variable.)

The two remaining facilities are used to represent work to and from locations other than the eighteen member sites and to experiment with various network-level service offerings. For example, requests to obtain a particular type of processing without designating a specific supplier (e.g., at "lowest cost" or with "fastest turnaround") will be sent to this site for allocation.

The model operates with a basic time unit of one week. This time interval was selected as being small enough to reflect

overall network dynamics, large enough to be computationally feasible, and compatible with typical weekly, monthly, quarterly, and annual decision cycles.

Alternative Uses of the Model

Several different versions of the simulation model are being developed. In the "single site" version, only one site will be considered at a time -- typically, a representation of the current computing situation at the user's institution. In the hands of local administrators and/or computer center directors, the model can be an effective tool for planning and exploring such areas as internal pricing policies, capacity adjustments, hardware utilization, and funding mechanisms. For example, the computer center director could look at the simulated effects on service of adding more terminals, increasing memory, and/or upgrading the CPU. Since service pricing and other financial parameters are included in the data for each site, one could also use the single site model to analyze the effects of changes in prices or cost recovery policies.

The model can be used as a "straw network" in which all sites are included, but only one site can modify its policies or behavior during a run. If work flow is permitted among sites, various relationships between the subject site and the hypothetical static network can be explored. This will provide a simulated network for individual sites to look at alternative modes of network participation. Any one site can therefore explore a variety of policies and decisions vis-a-vis an outside network. For example, it could study the effects of external purchases of computing by allowing its local users various levels and types of access to network resources. An institution could also explore the consequences of alternative policies regarding the sale of its own computing services to other users on the network. The straw network model can similarly be used to examine network-wide policies by fixing all sites and only varying the parameters that describe network organization and management. Any institution can utilize either the single site or the straw network package for internal analyses by gathering the data required to describe its site.

The "full gaming" model will simulate an actual dynamic network with each site modifying its data representations and policies as it acts and reacts to the decisions, offerings, and performance levels of all other sites. Participants will be able to discuss their decisions, to enter into simulated contracts, and

to interact with each other as if they were involved in an actual network situation.

Policy and Behavior Modeling

Every simulation run begins with the input of appropriate policies, practices, and/or management decisions for each site. These policy selections control various decision points within the model so that the actions taken will accurately represent each site (or an alternative that a site might wish to test).

The policy selections determine many aspects of site and network activity. Policies are divided into three main areas: supply of computing services, demand for computing services, and the allocation of supply to meet this demand.

Supply policies control budget expenditures (e.g., for hardware, software, and user support), hardware configuration changes, the selection of service types offered, prices charged for computer resources, and the type of user support offered. For example, one institution may choose to increase a particular computing resource (e.g., line printers) if this resource becomes heavily used and creates a bottleneck. Another may select a policy that calls, instead, for raising the price of such a heavily-loaded resource so as to discourage its use.

Demand policies determine the level of computer use desired by local users, restrictions on this use, and the process by which supplying sites are selected for meeting this demand. A typical institution might not place any limits on the amount of money spent over the network by externally funded researchers, but might require that all instructional computing be done in-house. In selecting a possible supplier, one group of users such as students may prefer a supplier that offers the lowest prices, while another group such as researchers may seek the supplier with the fastest turnaround.

The third major area of decision making deals with the allocation of computing resources. If it is determined that a site cannot satisfy all demand requested for the week, the appropriate market (supply allocation) policy must be invoked to determine which demands will be satisfied and which will be left unsatisfied. For instance, one institution may choose to give internal users preferred treatment, a second may treat all users on an equal basis, while a third may establish priorities for selected services.

The combination of policies selected by an institution represents its "profile" with respect to computing services. By changing the input data, it is possible to modify these decisions and experiment with other profiles in order to determine the effect of different policies on the individual institution and on the network as a whole.

Overview of Experiments

The model can be used to study many issues critical to the understanding of a network and its likely impact on participating institutions. The following investigations were considered to be of particular relevance and interest:

1. Network Organization and Management

A strong central organization would facilitate usage of multiple remote sites, but would require additional funds in order to provide services such as account numbers for multiple-facility use, central billing services, and standardization of procedures. An alternative to this is to rely on a series of bilateral agreements between various institutions on the network. Related studies will focus on alternative network organizational structures and the impact of a range of central policy decisions.

2. Network Composition

Different combinations of network participants may produce quite different network flows. For example, if there are few large supplying sites and many buying sites (large or small), network flow might have quite different characteristics compared to a network in which the traffic primarily involves the bilateral exchange of services between institutions. The network might also be composed of sites with various attitudes towards computing. A network composed of "entrepreneurs", for example, may look quite different than a network consisting of more conservative institutions.

3. Site Specialization

Could a network lead to centers of specialization having different emphases such as low price, good support, or fast turnaround? Will a stable network require consistency among sites or a balance of extremes? What is the viability of centers that try to specialize in this fashion, and what are the user responses to these services?

4. Communications Costs

A prime research problem is to determine the ways in which communications costs affect the volume and mix of network traffic. Further, it is important to investigate the impact on computer

operations of these changes in the work mix.

5. Network Stability

Designers of networks must consider the conditions under which institutional behavior might become unstable and lead to wild swings in network flow. Factors that might lead to this include lowered barriers to switching sites, price changes or competitiveness among network sites, shifts in behavior patterns, sudden perturbations in capacity or demand, and changes in technology.

6. Alternative Strategies

Typical approaches followed by network participants might include: an entrepreneurial attitude, a conservative attitude, an attempt at cost minimization, and an effort to maintain a zero net balance of trade.

7. Network Growth and Evolution

What is the potential for growth due to non-suppliers joining the network (for example, large numbers of small institutions) or wider exchange among existing members? How would growth affect the existing sites in their willingness to expand total system usage by either utilizing excess capacity or acquiring new capacity? What are the stages that a developing network goes through as it matures? Are there critical periods of development?

8. Quality of User Information

How is user behavior affected by different levels in the quality and variety of information about such matters as prices, turnaround, and accuracy of competitive services? Is the expense of providing status information to a user justified? What effect might this have on migration? What are the effects of perfect, imperfect, or lagged information on usage at a site?

9. Quality of User Services

What are the effects of improved program documentation, on-line user aids, "hot line" consulting services, and program directories? Do such improvements increase the rate of acceptance of a computing service by remote users?

10. Pricing Policies

In a cooperative network composed of independent institutions, there are many questions concerning the impact of sites using different pricing strategies. What are the effects on the institution and on the network of various types of pricing policies? What are the effects of price regulation?

11. Impact of the Network on Institutional Activities

What is the effect of network participation on such areas as institutional

computer operations, academic and scientific research programs, instruction, libraries, and science information exchange.

12. Economic Impact

The economic impact of network affiliation can be reflected in several areas including potential cost savings, potential increases in expenditures as new services are made available to users, cash flow and balance of payments, and budgeting for external purchases. How critical are these factors in governing network behavior?

13. Provision of Special Services

What impact on the institution does the decision to provide special services have? What is the impact on budgets, hardware, user support, etc.?

14. Effect of Low-Cost Minicomputers

How will the proliferation of minicomputers affect network participation?

Initial Experimental Results

The experiments performed thus far are of a preliminary nature, and it is dangerous to draw many hard conclusions before a full set of institutional behaviors and policies can be incorporated into the model. However, several interesting trends have been observed.

The network and institutional arrangements investigated indicate that equilibrium network behavior tends to be quite stable. Even the introduction of relatively large displacements did not result in unstable behavior. A number of stabilizing factors appear to be sufficiently strong to dampen oscillatory movement quite rapidly.

The networks examined so far also revealed a substantial resource-sharing potential. When there were large discrepancies between sites with respect to price, turnaround, or user support -- and the data certainly indicate that such discrepancies do exist -- there was a gradual shifting of workloads between the processing sites. Assuming that site hardware costs remain unchanged in the short run, these shifts should result in reduced job costs to users and improved turnaround. The major inhibition to such network flows seems to be institutional policies restricting network usage in order to control cash flows.

As further data on institutional policies and decision rules are obtained, the various experiments described earlier will be conducted. These

simulation runs should yield a great deal of additional information about the effects of various institutional policies on network performance.

Further information about the simulation model and the initial research results obtained may be found in the phase one project report to the NSF. (3)

Benefits

The benefits of this research effort will not be confined to the eighteen participating institutions. Individual sites wishing to conduct more detailed in-house studies will be able to utilize the single-site and straw-network models for this purpose with a minimum of effort. It will also be practical to adapt the models to study particular state or regional networks. Results will be disseminated to the general educational and research community through publications, conferences, and seminars. They should be of wide applicability to individual institutions that are considering network participation, to designers and managers of state and regional networks, and to educational and research policy-makers at state and federal levels. The major impact, however, will be from the research.

References

1. Emery, J.C., "Implementation of a Facilitating Network", Policies, Strategies and Plans for Computing in Higher Education. EDUCOM, Princeton, New Jersey, 1976.
2. Greenberger, M., J. Aronofsky, J.L. McKenney, and W.F. Massy, eds. Networks for Research and Education Sharing of Computer and Information Resources Nationwide. MIT Press, Cambridge, Massachusetts, 1974.
3. Year 1 Report to the National Science Foundation on the Simulation and Gaming Project for Inter-Institutional Computer Networking. Grant # DCR75-03634. EDUCOM, Princeton, New Jersey, 1976.

COMPREHENSIVE EDUCATIONAL
COMPUTING IN A
NETWORK ENVIRONMENT

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This paper describes an approach to stimulating and supporting educational computing in a network environment. Based on a rational planning model, the approach employed principles of curriculum planning, instructional design, and facilitative networking in moving toward a comprehensive plan. The plan began with an analysis of educational functions to be performed and then a design and management plan for reaching the plan's objectives. The result is a comprehensive set of services which is widely utilized in a major network.

The University System (of Georgia) Computer Network (USCN) is composed of thirty-four institutions which share a Control Data CYBER 70, Model 74. The USCN began in 1970 with the assistance of a grant from the National Science Foundation. Initially, each site functioned independently in the Network with monthly meetings for status reporting. In 1975 the Network was subdivided into six regions with representatives from each forming an Executive Committee. Currently, the Executive Committee provides liaison between the Network sites and the Central Site.

The Central Site houses the CYBER 70 and two IBM 370/158's. There are four functional divisions at the Central Site, one of which has major responsibility for educational and technical support services for the Network. This Division is composed of personnel in User Services and Educational Support. All personnel are available for site visits, although there is a designated traveling consultant working out of the User Services Department.

The Division of Educational and Technical Support is dedicated to the goal of improving the effectiveness and utilization of educational computing. In the past two years, the USCN has progressed from the point of near zero level instructional computing to a high degree of activity in the area. Research computing in the Network has also shifted from total reliance on batch processing to moderate use of interactive

applications.

The Division of Information Services provides students, faculty, and others with low-cost access to a variety of information sources. The Georgia Information Dissemination Center, A Department of this Division, provides literature searches on about 20 bibliographic data bases. Another department, COSMIC, is a NASA contracted technology distribution center.

The Division of Institutional Services does not directly serve the Network but is, rather, a service operated for the Administrative staff of the University of Georgia. This Division performs the functions of analysis, design, development, and implementation of administrative and data base applications.

The fourth Division, Computer Services, operates the Central Site facility for the Network and the University of Georgia. This Division consists of operations personnel and operating systems programmers for all systems. The Division is primarily responsible for maintaining operations 7 days a week, 24 hours a day.

The Division of Educational and Technical Support is managed by personnel who have a background in, and understanding of, educational innovation, and is staffed by persons with technical competency. This combination of personnel is a significant factor involved in the approach to educational computing which has been employed. The variety of personnel expertise has

established conditions which encourage computer utilization by Network faculty and has circumvented conditions frequently identified as inhibiting widespread utilization.

In addition to appropriate staffing, successful implementation has been enhanced by utilizing principles of curriculum development and instructional design that have long been accepted in practice, if not in theory. Briefly, these principles consist of the following:

- 1 - Curriculum development is a continuous, on-going process;
- 2 - Curriculum development should begin with real, existing, instructional problems;
- 3 - Curriculum development should focus on many subject areas simultaneously rather than pursue a piece-meal approach.
- 4 - Curriculum development should include the participation of those who will implement the results;
- 5 - Instructional design should follow along the lines of the learning cycle;
- 6 - Instructional design should rely upon the expertise of appropriate personnel for making decisions about content, learners, learning, and technology.

Four of these principles have their counterparts in the area of computer networking, as well. Slightly modified, those principles applied to facilitative networking consist of the following:

- 1 - The operation, growth and modification of a network is continuous throughout its existence;
- 2 - Network support must focus on real, concrete, problems as perceived by network participants;
- 3 - Problem-solving by network personnel must focus on many problems simultaneously, not attempting to solve one problem at a time;
- 4 - Network operations must be planned cooperatively by those who are to participate in the Network.

These principles undergird the day-to-day operations of the Network as well as the intermediate and long-range planning. The remainder of this presentation describes how the Division of Educational and Technical Support has fostered educational computing in the University System Computer Network, including the University of Georgia campus.

The general goal of the Division is to provide support and leadership for all educational users of computer technology in the University System of Georgia. This goal includes providing assistance in all phases of educational computing - from stimulating greater and improved

utilization to providing "crisis intervention" for routine users. More specifically, the goals of this program include:

1. To motivate educational personnel to increase and improve their utilization of computers as a major tool for education.
2. To provide courseware and software for educational applications.
3. To promote the development of curricula and lessons for computer-based educational systems.
4. To assist educational personnel in the acquisition of competencies necessary to utilize the computer as an educational tool.
5. To provide educational and training opportunities for users and supportive personnel of computer-based educational services.
6. To develop innovative applications of computers in education.
7. To provide technical assistance for all routine functions of computers used in the educational environment.
8. To assist in the evaluation of educational applications of computer technology.

In order to accomplish these goals, some means of practical implementation had to be developed. Therefore, objectives were defined in behavioral terms with a series of activities expected to evolve from the definitions. For purposes of analysis, a matrix was constructed to plot categories of computer applications against specific functions which are an integral part of any educational process. The categories of applications were defined by the National Center for Educational Statistics' (NCES) Handbook:

1. Computer-Assisted Instruction
2. Computer-Managed Instruction
3. Computer-Developed Instruction
4. Computer-Assisted Testing
5. Computer-Assisted Guidance

The specific educational functions used in our analysis include:

- 1) Diagnosis of Learner's Needs
- 2) Management of Instructional Objectives
- 3) Design and Implementation of Teaching Strategies
- 4) Coordination of Educational Media
- 5) Monitoring and Measuring Learner Achievement and Instructional Effectiveness
- 6) Generalized Management
- 7) Research and Development

The resulting matrix was of considerable value in identifying worthwhile activities and for allocating resources to those activities of highest priority. Of course, general research is also of highest priority in institutions of higher education and is, therefore, strongly supported in the Network as well as those applicat-

ions derived from the matrix.

The process of deriving appropriate objectives is one of the primary activities in which we participate and provide leadership. In fact, this activity involves considerable time and effort to interact with diverse groups of users and to assist with the definition of objectives which are important to the users. These activities can be categorized as coordination functions. When the objectives are defined and clarified, we find the functions to be systems development and installation, demonstration and training of users, and continued technical support for system maintenance and upgrading.

All activities which support educational computing from the Central Site and from within the Network are coordinated through representatives of the Network. Monthly meetings are held by the Network Executive Committee within the six regions of the State, an annual meeting is held for all Campus Coordinators, and meetings are called about twice a year by Central Site staff for all Campus Coordinators. All of these sessions serve the purpose of presenting current developments, discussing additional needs, setting priorities, clarifying Central Site activities, and making other decisions relative to development activities - such as who will do the work, what is to be done, and who will provide advice and support.

A Network traveling consultant, who functions much as a circuit-riding preacher, coordinates visits to campus sites for individual discussion of local needs within the Network. Though a single individual is designated as the circuit rider the actual visits may be made by whichever staff member can provide the greatest amount of assistance.

In addition to coordination with the Network, the Central Site staff coordinates its activities with the Academic Advisory Committees of the Board of Regents. These committees are composed of faculty representatives of each academic area from each campus. We have not yet finalized arrangements with all committees but it appears that they will provide a valuable advisory board for evaluating the content of computer applications and will assist in making curricular decisions pertaining to adoption of applications.

A major function of the Division involves selecting, evaluating, and acquiring existing courseware and software for educational applications. During the testing phase, the documentation of reported applications is reviewed for complete-

ness and accuracy; frequently, revision of both the software and documentation is required before the material can be released for general use. Occasionally, the content of the courseware also requires editing; academic departments in the University System are consulted whenever possible for this function.

The Division provides leadership for creating both courseware and software for use in all academic disciplines and at all institutions to author new curriculum and instructional materials, and to create software whenever necessary. In return for this assistance, the materials are added to the network library for general use when applicable. In this way, we will be able to build a library of useful packages which reflect the unique requirements of our University System. Every attempt is made to assure that authors of new materials are given appropriate consideration and recognition for their efforts in carrying out this function.

In addition to standard statistical packages, three major applications are functional. The first application, CAI libraries, was preceded by an extensive search for CAI courseware which was operational. Acquisition of existing CAI material was selected as the initial implementation for three basic reasons:

1. The central site staffing was proceeding slowly and deliberately, therefore, we were not able to allocate a great deal of personnel resources to original development.
2. The immediate presence of a library of operational CAI lessons would provide a source for demonstrating the advantages of this instructional mode.
3. The extent to which faculty would use these libraries would provide some preliminary indications of the prevailing general attitude towards computer utilization.

The System faculty has responded to these materials in a very positive manner. The use has grown from fifty to fifteen hundred accesses per month. Furthermore, faculty are submitting to us lessons which have been used on local compuses, thereby allowing system-wide availability. We have noticed that this sharing of materials has had a beneficial effect both on instructional improvement and on computer utilization. Apparently, the CAI lessons are a focal point around which an intra-system professional camaraderie is developing. Authors are quite responsive to their colleagues' suggestions for editing lessons, and from this type of dialogue a consensus of instructional intent and content seems to be evolving. Most of the lessons are written in the BASIC language; as more users learn BASIC we expect the libraries to expand further. Currently

there are about four hundred lessons in ten subject areas.

The second application to be installed was a computer-assisted test construction system (TCS). A search of available systems revealed that either the programming languages were incompatible with our hardware or the design did not satisfy our requirements. Consequently, we developed our own system from vendor utilities with local design and programming. The locally created modules are programmed in Fortran and run on the CYBER 70/74. The system incorporates elements of interactive and batch processing. Briefly stated, the following major functions are available:

1. Data base management (input and editing capability) for test item files
2. A conversational mode interactive module for searching the item files and printing test items
3. Test and item analysis reports

The TCS currently has sixteen data bases from as many subject areas. The interactive search of these files allows the user to specify four parameters: content category (a type of index), difficulty level, cognitive level, and type of test item (multiple-choice, true-false, essay, or short answer). The user also specifies the quantity of items desired.

This system reached operational status in November of 1976. Since that time, it has received a very warm reception. During November and December, faculty in fifteen institutions began regular use for generating classroom examinations.

The third major application to be installed was an easy-to-learn authoring system. Several alternatives were initially considered and extensively evaluated. Among those considered were IDAF, Coursewriter, TICCIT, PLATO, PLANIT, and MULTITUTOR. The criteria for evaluating each system were that the language be flexible enough to be used with any instructional strategy, that it be powerful in terms of the number of functions which could be efficiently performed, and that it be easy to learn with little or no computer knowledge. Concern with local curriculum requirements caused emphasis to be placed on the ability to locally author lessons over the existence of lessons authored elsewhere.

MULTITUTOR has been all we had hoped it would be. The language is now widely used in the Network on a variety of terminals and will soon be used, with graphics, on a plasma display terminal. We currently have about 200 lessons and plan to translate many more from other languages as well as adding those developed locally.

Other applications at various stages of development include a computer-assisted guidance system, an interactive testing system, a course evaluations analysis system, a student record keeping system, and an extensive interactive statistical analysis system.

The existence of many applications available to users makes apparent the need for demonstrating their value and teaching faculty members to use them effectively.

In fact, the effort put forth in providing educational experiences for users is considerable and a realistic goal is the conversion of many of our present activities to computer-based educational strategies. Presently, we teach free, non-credit, courses and/or seminars each week for one hour every day. Topics for these courses include programming languages, job-control languages, computer center orientation, operating systems, utilities, and software packages. Most of the users who attend these sessions are graduate students.

Educational applications training is aimed at faculty members who want to author lessons and/or curricula for their own disciplines. The schedule for teaching is kept flexible to meet the needs of busy faculty members. Since September 1976, we have conducted these sessions an average of twice a month to groups as small as ten and as large as one hundred fifty. The response has been outstanding and the requests are still increasing within the Network.

Technical assistance is provided for planning, implementing, using, and evaluating hardware and software systems. The Division maintains files of descriptive material of user access equipment such as data terminals, printers, etc. for personal use by interested faculty. We also provide a central location for vendor demonstrations.

A staff of consultants is available during standard working hours to assist with all technical problems encountered by users. Technical assistance is provided to the Network by the circuit rider who spends much of his time around the State. He provides assistance with the remote job entry devices, the stand-alone systems in the Network, the interactive devices, and telecommunications. In addition, the Central Site maintains a technical library of manuals, journals, locally written documentation, and video cassette training materials which can be borrowed by users.

COMPUTER PERSONNEL REGULATION: A PARTIAL SOLUTION TO THE PRIVACY PROBLEM

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The accumulation and centralization of personal data into computerized databases is a necessity for collective self-interest in today's complex society. Private information about individuals can be used to improve the responsiveness of institutions to human needs. Unfortunately, databanks come into conflict with some individual rights, including the right to privacy. The privacy issue is defined and attempts to legislate guidelines for personal data usage is reviewed. Hardware and software techniques for database security already exist. The computer resource requiring the greatest scrutiny is the computer employee. Focus and analysis of a regulatory policy for computer personnel is the crux of this thesis.

Communications devices for information dissemination and data management techniques are primarily responsible for the geometrical growth rate of knowledge. The computer is the ultimate data management tool. Mass storage devices, such as IBM's 3850 MSS [1] for data storage, and analysis algorithms such as linear programming, CPM, and PERT allow strategy formulation in real time. The ordering of raw data masses into databases [2] through detection of logical data relationships supplies access paths and availability for analyses. The computer's ability to accelerate the access capability furnished the feasible cost effectiveness.

The economic scope and importance of knowledge has long been accepted. In 1597 Bacon said, "Knowledge is power," [3], probably paraphrasing a Biblical verse in Proverbs XXIV. Actually, knowledge is a resource. Machlup [4] estimated that in 1958 30% of the GNP of the US was expended on knowledge. A 1963 calculation indicates an increase to 43% of the GNP [5]. Mee [6] expects the knowledge industry to account for half the GNP by the year 2000.

A record-oriented society is a result of the need of the technocrats to organize and analyze data masses for decision making. These decisions form the bases for business, industry and government actions. These actions either control individuals or attempt to determine personal preferences and needs. When dealing with large numbers of people, these determinations and subsequent timely responses can only be provided by a computerized system. The methods of information accumulation,

guidelines for data storage, and depth of inquiry about people are the basic concerns in the privacy issue.

What is privacy? Westin views it as, "the claim of individuals, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others" [7]. Privacy is a combination of individualism, liberty, and autonomy. It is the power of the individual to determine whether he will perform a particular act or undergo a particular experience. However, the socialistic trend relegates the individual to the position of sublimating himself to the public good. This includes a diminution of personal liberties.

Computers are linked to the loss of personal privacy because they provide the instrument for accelerated intrusion. There is no doubt that computers effect the dissemination of information, but the cause and effect relationship between computers and the invasion of privacy is not direct. Bruck noted, "The use of computers, whatever other roles they may play..., has the potential to change the uneasy balance that exists between those exercising power and those upon whom it is exercised." [8] The problem is not the legitimacy of databases, but their conflict with other rights.

The unregulated collection and distribution of personal data has been under US government scrutiny since 1964. Regulation has focused upon information gathered for one pretext, but used for other purposes. Hearings have been held by the US Congress since 1965 [9]. These hearings have re-

sulted in the Fair Credit Reporting Act of 1970 [10] and, more importantly, the Privacy Act of 1974 [11].

The Data Protection Act in the Federal Republic of Germany in 1970 [12] and Sweden's Data Act of 1973 [13] are among 18 countries which now have privacy protection codes. However, these regulations have not approached the depth of systems analysis which computer professionals must inevitably view the ultimate protection problem.

If the assumption that computerized databases are a necessity in modern society is valid, then a microscopic examination of the data management system is required. Current discussions about database systems are centered around arguments of what information should be stored, who should have access, etc. A more immediate concern to the computer professional should be the internal protection of information from computer personnel. Superficial governmental regulations, dealing with the initial construction of databases and restriction of users, have no application to personnel who have unlimited access to existing systems. Normal hardware and software protection schemes are merely nuisances to the person with initiative or computer training who seeks access to the system.

A database represents a large investment. Frost and Sullivan [14] estimate that the collection, organizing and selling of data will exceed \$1.1 billion per year in the US by 1978. The ability to tap this asset can be a rewarding talent. Al Green's exploits (\$2.2 billion) [15] broke the Guinness record for swindles while the Union Dime Savings Bank (\$1.5 million) and Schneider swindle [16] illustrate lessor rewards. Other abuses are documented by Parker et. al. [17]. With the temptation of such a reward and criminal consequences so small, usually a brief imprisonment or less, the trend can be expected to continue. Schneider was rehired by the company which he swindled.

Conway et. al. [18] define information security as procedures to insure that privacy decisions are in fact forceable and enforced. This is the computer professional's responsibility. Security problems from a hardware and software standpoint are not novel. Allen [19] examined physical security, while a survey of security issues may be found in Hoffman [20]. The incorporation of security into systems design is a trademark of the MULTICS system [21]. National security created early uses for data encryption and hierarchical classifications of information [22]. This need-to-know scheme is necessary in a database environment. Each employee classification should be isolated

from the database influence of other positions. The modus operandi is usually planned this way, but the means for overlap, namely documentation, is readily available. Systems security does not protect, on a need-to-know basis, systems documentation. Schneider's swindle began after he found systems documentation and coding schemes in the trash outside a center. The intermediary employee, who has indirect contacts with the system, should be scrutinized to prevent unauthorized use. It is not sufficient to merely divide personnel by system access or no access (most systems do not have this delineation). Access by security matrix should be extended to all resources such as documentation and codes. Procedures for the complete disposal of hard copy output should be implemented. Codes and passwords at several levels of machine interface should be changed regularly and irregularly, but at short intervals. For the security of a database to remain status quo is to create temptations.

The obvious approach to the personnel issue is to hire trustworthy employees. Security checks should be more stringent (existent in some cases) and stability evaluations more frequent. Audit trails on personnel usage of the system should be incorporated into the system and examined regularly. A mood of security among personnel must be created. Gotlieb and Borodin point out, "The overall conclusion is that the data bank issues are not primarily technological, but rather administrative, social, political, and legal, arising out of changes in relationships between individuals and organizations." [23]

Privacy laws must address specific personnel issues with the esoteric political issues. For example, stiffer penalties for misuse of information by computer personnel and secondary users are necessary. Disclosure compensation penalties for personnel are needed. The bonding of personnel would result in historical perspectives of personalities. The licensing of computer personnel, especially database people, is long overdue.

Regulation by the computer profession must overtake the technological surge. A code of ethics exists, including articles for disclosure and protection of privacy [24], but is not widely accepted. Stronger professional involvement is essential or politicians alone will decide the issue. Data culprits should not be allowed to return to the computer industry. A professional organization should have the power to revoke that privilege. Schneider and others have received light civil penalties and have been rehired by their former employers or others in similar industries. In these cases the penalty has not matched

the damage done to the computer profession. Requiring compliance and other missives in the profession should be monitored and published. The computer profession must take more interest in this problem and provide society with a realization that the human element is the weakest link in safeguarding confidentiality.

Only recently has society decided to grapple with the problems of pollution and energy. The public has been unreceptive to solutions to these issues because of costs. Solutions to the privacy/security problem will be expensive. The US Office of Management and Budget estimates [11] the five-year cost of implementing the Privacy Act of 1974 will range from \$1.1 billion to \$1.6 billion. Goldstein [25] predicts that annual privacy costs for personal data systems could account for as much as 73% of the annual operating costs of some industries. The computer profession must force action now so that costs may be amortized over a longer period of time. Computer scientists must plan systems protection, including personnel checks, before the design is irreversible or economically unfeasible to alter.

The personnel issue should be decided in parallel with the more mundane concepts of database existence. The profession cannot tolerate or survive many more dramatic criminal or negligent acts to databases. It must be emphasized that safeguarding privacy is a people problem.

REFERENCES

1. Introduction to the IBM 3850 Mass Storage System (MSS), GA32-0028-1, IBM Boulder, Nov. 1974.
2. Martin, J. Computer Data-Base Organization. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1975.
3. Bacon, Francis. Meditationes Sacrae De Haeresibus, 1597.
4. Machlup, F. The Production and Distribution of Knowledge in the United States. Princeton, NJ: University Press, 1962.
5. Burk, G. Knowledge: The Biggest Growing Industry of Them All. Fortune (Nov. 1964).
6. Mee, J. The Explosion of Knowledge. Business Education Forum (Apr. 1971), 44.
7. Westin, A. and Baker, M. Databanks in a Free Society. NY: Quadrangle Books, 1972.
8. Bruck, K. To Redress the Balance. Proceeding of the ACM National Conf., 1970.
9. Hearings, Special Subcommittee on Invasion of Privacy. Special Inquiry on Invasion of Privacy, part 1, June and Sept., 1965.
10. Fair Credit Reporting Act. US Statutes at Large, vol. 84, Part 1. US Gov't. Print. Off., Washington, DC, 1971, 1128.
11. Privacy Act of 1974, House Report 93-1416. Washington, DC: Gov't. Print. Off., Oct. 2, 1974.
12. Niblett, G. Digital Information and the Privacy Problem. Paris: Organ. for Economic Cooperation and Dev., 1971.
13. Sweden's Data Act. Computer Decisions, (Nov. 1973), 50-51.
14. Markets for Data-Base Services. NY: Frost and Sullivan, Inc., 1973.
15. I Led 66,000 Lives: The Adventures of Equity Al Green & His Silent Partner in Crime IBM 360. Rolling Stone, (May 9, 1974), 51-52.
16. Rothman, S. and Mosmann, C. Computers and Society. Chicago: SRA, 1976, 353.
17. Parker, D., Nycum, S. and Oura, S. Computer Abuse. Menlo Park, CA: Stanford Research Institute, 1973.
18. Conway, R., Maxwell, W. and Morgan, H. On the Implementation of Security Measures in Information Systems. CACM 15, (Apr. 1972), 211-220.
19. Allen, B. Danger Ahead! Safeguard Your Computer. Harvard Bus. Rev., (Nov. - Dec., 1968), 97-101.
20. Hoffman, L. Computers and Privacy: A Survey. Computing Surveys 1,2 (June 1969), 85-103.
21. Graham, R. Protection in an Information Processing Utility. CACM 11,5 (May 1968), 365-369.
22. Bingham, H. Security Techniques for EDP of Multilevel Classified Information. Doc. RADC-TR-65-415, Rome Air Dev. Cent., Rome, NY, Dec. 1965.
23. Gotlieb, C. and Borodin, A. Social Issues in Computing. NY: Academic Press, 1973.
24. Code of Ethics, Conduct and Good Practice for Holders of the Certificate in Data Processing. Chicago: Institute for Certification of Computer Professionals, 1974.
25. Goldstein, R. The Costs of Privacy. Datamation, (Oct. 1975), 65-69.

COSTS OF COMPUTER CENTERS IN HIGHER EDUCATION

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To allocate four percent of the total college budget for computer center operations seems to have become acceptable. A 1976 study of universities with a graduate program in computer science and enrollment between five thousand and fifteen thousand found that they dedicate, on the average, 2.32 percent of the total budget to computer center operations. This fact could have several implications for university administrators.

The cost of having and operating a computer is one of the largest, if not the largest, costs on a university campus. As such, the computer costs receive much criticism. The purpose of this paper is to discuss the position that the computer costs have grown and are disproportionately large with respect to other costs on college and university campuses.

Traditionally, college and university computer centers were financed primarily by the same governmental agencies which funded research in the physical and biological sciences and engineering. The National Science Foundation, the National Institutes of Health, the Department of Defense, and the Atomic Energy Commission not only gave direct grants to institutions for capital equipment and operating funds, but also allowed the colleges and universities to recharge much of the cost of the computer center to project grants to which the services were provided (Balderston, 1974:66-67). The Carnegie Commission on Higher Education (1972:135) reported that the trend in the 1970's has been toward more internal computer usage and less support from extramural sources.

Balderston (1974:67-68) indicated "... prices of computing, per unit of effective service rendered, have continued to fall." However, the number of uses and the total computer usage have risen at such a pace that they have outdistanced the expected cost reductions. Administrative demands, instructional needs, and research requirements all have placed more importance on the computer. The mode of processing has also been expanded from old-fashioned batch processing to include "demands for timesharing service

and for numerous types of on-line computing, for controlled experiments, data-monitoring, and process-control."

The status of the computer on university campuses has, therefore, changed considerably. The computer is no longer bought by and for the benefit of some off-campus institution which, in turn, provides grants for a relatively few faculty members and students to work on projects for the organization. Instead, the computer is now being used by teachers and students in all areas of study. It is also being paid for by the teachers and students, rather than by some extramural source. Thus, the computer and its costs are being scrutinized more closely by all the faculty and students than ever before. The principal criticism of the computer seems to be the high costs of obtaining and operating it.

In February, 1967, the President's Science Advisory Committee (1967:3-4,66) published a report on computers in higher education. In its report the committee compared computer service costs to comparative library and chemistry laboratory services and found them to be reasonable. The commission further reported that computer costs, on the average, were approximately equal to four percent of the total university budget. The data upon which the commission's report was based were from 1965 when "less than five percent of the total college enrollment, all located in relatively few schools, had access to adequate computing facilities." However, the aforementioned four percent of the total budget for computer operations seems to have remained an acceptable percentage of the budget to be earmarked for computer services. The Texas State Auditor's

Office was using this figure for comparison purposes when studying state college and university budgets.

A 1976 study by Bane indicates that the assumption that all colleges and universities should adhere to the "magic" four percent of the total budget for computing services might be a poor decision. Bane was studying colleges and universities with enrollments between 5,000 and 15,000 students and offering graduate degrees in computer science or information science. He tested the null hypothesis: There was not a significant difference between the mean percentage of the total budget for computer operations in these colleges and universities and the four percent determined in the earlier study. To test this hypothesis questionnaires were sent to the Computer Center Directors of these institutions. Thirty-one responses were received from directors who answered both of the following questions:

1. Total proposed budget for the institution.
2. Total proposed budget for the computer center.

A percentage of the total institutional budget dedicated to computer center operations was determined by dividing the total proposed budget for the institution into the total proposed budget for the computer center and multiplying the quotient by 100.

The one sample t , as described by Cochran and Holliman (1974:23), was used to test for the significant difference of the mean percentage of the total budget for computer operations in the selected colleges and universities and the four percent determined in the earlier study. For the purpose of using the one sample t test, the four percent of the earlier study was used as the mean of the population. The following formula was used:

$$t = \frac{u - \bar{X}}{S_{\bar{X}}}$$

where

u = the mean of the population
 $\bar{X}$ = the mean of the sample
 $S_{\bar{X}} = s / \sqrt{N}$, s = the sample deviation of the sample
 N = the number of the sample.

For the thirty-one respondents to both questions, the following values were calculated. The mean percentage of the total proposed budget for the computer center was 2.32 percent. The standard deviation for this group was 1.23, and the computed t value was 7.45. The critical value needed to reject the null hypothesis was 3.646. Therefore, the null hypothesis was rejected, and it was determined that

the mean percentage of the total budget allocated for computer center operations of the selected colleges and universities was significantly different from the four percent of the earlier study.

Before drawing conclusions based upon Bane's results, the restrictions of his study should be restated. First, only colleges and universities with between 5,000 and 15,000 student enrollment were included in this study. Further, the institutions must have had a graduate program in Computer Science. These are not what might be considered "average" schools. They have slightly lower than average enrollment, and since they offer advanced degrees in Computer Science, they probably tend to be more research-minded than the average school their size.

Realizing the above limitations, the following implications might be made as a result of this later study:

1. While four percent of the total university budget might well be the "average" that is allocated for computer center operations, it should not be considered the "ideal" for all colleges and universities. Instead, each institution should seek out other schools of similar size and programs. Then compare itself with these comparable colleges and universities, not a mythical four percent.
2. It seems that the colleges and universities in this study were allocating significantly less, on a percentage basis, than the accepted four percent. This fact should be included in studies concerning the optimum size of higher education institutions.
3. If the colleges and universities which participated in this study are, in fact, representative of all colleges and universities today, then criticisms of the rising computer expenses can be rebuked. For, if anything, percentage-wise the costs have decreased with respect to other expenditures.

References

1. Balderston, Frederick E. 1974. Managing Today's Education. San Francisco, California: Jossey-Bass, Inc.
2. Bane, Charles W. 1976. "A Comparative Study of Computer Utilization at East Texas State University." Unpublished EdD dissertation, East Texas State University, Commerce, Texas.
3. Carnegie Commission on Higher Education. 1972. The More Effective Use of Resources. New Jersey: McGraw-Hill Book Company.
4. Cochran, Samuel W., and Joanne S. Holliman. 1974. Cheat Sheet for Stat. Commerce, Texas: East Texas State University.
5. President's Science Advisory Com-

mittee. 1967. Computers in Higher Education. Report of the President's Science Advisory Committee. U. S. Educational Resources Information Center, ERIC Document ED 029 518.

EDUCATIONAL ADMINISTRATORS LACK OF RESPONSE TO THE
PROFESSIONAL ADVICE AND HARDWARE REQUIREMENTS OF
THE DATA PROCESSING INSTRUCTOR

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Information is needed in all organizations, including Community and Junior Colleges, for planning, decision making, control and forecasting. This need is generally known by administrators but many times, almost completely ignored.

Administrators have not always given appropriate emphasis to information preparation and as a result the following pressures have tended to place an overwhelming burden on those directly involved in the processing of needed information: 1) Increased Paperwork Volume. This involves the growth in size and complexity of the organization, increased requirements for information from both internal and external sources, and the demand of those same administrators for more timely and qualified information. 2) Demand For Timeliness. Meaningful information is timely information, however, as the volume increases the speed of processing decreases. Information at this time may reach those requesting it but its validity has diminished to an extent that it is less meaningful. 3) Demand For Quality. Administrators must have accurate information if they are to control and expanding organization. However, if a community or junior college's data processing operation is strained to and possibly beyond the capacity for which it was originally planned (if any planning originally existed), inaccuracies will begin to appear. Inadequate control will permit inadequate performance. This will precipitate the administrators demand for better quality in the information he receives. 4) Pressures From Outside Changes. Rapid changes take place in the world, socially, economically, and technically. These changes have a definite and significant impact on the environment in which organizations must operate, on the planning that needs to be done, and on the information that must be produced. 5) Costs. The increased and increasing costs of clerical labor, materials, and other expenses for processing data require eventual administrative attention on a periodic basis.

Information can be gathered and improved on in many ways. Better information may be obtained by using improved manual methods, non-computerized machine methods, computerized techniques, or some form of any or all of these. It is common knowledge that general characteristics desirable for computerized data processing are: 1) Large volumes of input. 2) Repetitive projects. 3) Necessity for greater speed in processing. 4) Necessity for greater accuracy. 5) Complexed operations. Administrators of educational institutions it seems are primarily graduates of systems of higher education, have little or no experience in the area of information processing in any form, and are basically concerned only with the operation of the institution academically. What they fail to realize is that the total environment of an educational institution include an efficient and worthwhile information processing system. If in the institution there is a Data Processing Technology, then there is no reason not to seek its professional advice. This is not being done. Much has been said about the inadequate programs for the education of teachers and/or instructors in the area of computerized information processing and the barriers that exist inhibiting these programs. Now however, consideration must be given to educating the administrators in the same manner as well as knowledge of their true resources. The whole realm of computer assisted education and administrative information processing must be kept abreast of by teachers, educators, and administrators if the small campus environment is to survive in our computerized society of today.

MAINTAINING USER DEPARTMENTAL RELATIONSHIPS IN A UNIVERSITY COMPUTING ENVIRONMENT

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A University computing center must maintain relationships with many different publics. Primary among these publics is the academic departments. The role of the University computing center, present and future, is examined with respect to providing computing services to faculty and students.

As a service organization, the University computing center must maintain relationships with many different user publics. Primary among these publics are the students, faculty, and the university administration. These are the constituents of the various user communities. A user community may represent a segment of an academic department or members from several academic departments or administrative offices. As seen from Figure 1, the University computing center can be viewed as the focal point upon which computing services emanate.

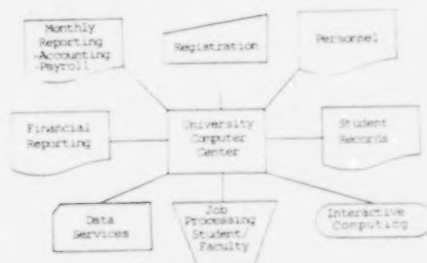


Figure 1. The University computer center as a provider of many services.

Although viewed as a central facility, computing services may be dichotomized--that is, academic vs. administrative. Whatever configuration exists, there is a multi-public user community that must be serviced. The objective of Computer services is to assist various users on campus to attain their goals in a most efficient way. Some typical uses of computer services are implied by

Figure 1 but general academic uses would include assisting faculty researchers with their research, data collection needs and analysis and training students in various disciplines.

More generally, the primary objectives of computer services are to provide:

- the computing resources necessary to support the instructional process requiring information processing.
- the means to educate students, faculty, and administrators on the usefulness and importance of computers in the educational process.
- continual user education on software advances and new data analysis techniques as it relates instruction and research.
- information processing for areas of research and public services in accord with the institution's goals in these areas.
- continual review of services rendered in terms of improvement or termination.

Maintaining favorable relationships with the university community is a complex situation at best. A simplified diagram of various groups interacting with the University computing center (UCC) is shown in Figure 2.

All of these groups are not represented at all institutions nor is each of these groups mutually exclusive. For example, a member serving on the user committee, which serves in an advisory capacity, may also be a member of a user group. A member of the university administration representing top management may likewise serve on the user committee. The academic departments, various administrative offices and student users of

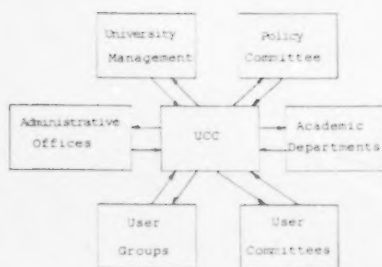


Figure 2. Various agencies interacting with the University computing center.

the computing services all vie for the University computing center resources.

For the university to meet user demands, a delicate balance between budget constraints and expenditures for hardware, software, and people (consultants, programmers, operators, office staff) must be maintained. In many cases, user requests cannot be granted due to budgetary constraints. However, to best serve the computing needs of the university community, the computing services staff must accomplish the following steps:

- evaluate in concert with the various users, the short term and long term computational needs of the university community.
- examine possible alternative uses of available resources to serve current needs and/or future needs.
- develop objectives which are realistic within the limitations of the budget.
- prioritize needs--that is, determine those needs to be serviced now and those needs to be deferred.
- implement those requests which are in accord with established priorities and budgetary constraints.
- manage all resources in the most cost effective way possible.
- continuously review priorities for modification, reordering, or deletion.

To be able to manage the computing resources in a cost effective way and still meet user demands (or at least a number of the demands) requires almost daily judgments on hardware, software technology, and staffing. It is difficult to single out any of these factors as the most important. A computing center may have the most capable staff to be found anywhere but without adequate hardware and the appropriate software to service user needs, the staff is essentially useless. If a computing center has the most advanced large-scale

computing hardware but cannot provide adequate user access to this machinery or cannot provide an adequate staff to interface with the users, then the advantages of a large-scale machine are not significant.

A computing services organization is built upon people. That is, people who service the user and who listen to his problems. In many installations, the user may never see the hardware that runs his jobs except maybe as a tour through the computing center. But whether the user has "hands on" experience or not, his interface with the hardware and software is generally through the computing center staff. The user's impression of the computing center does not evolve from the equipment and software but rather through his dealings with computing center consultants, machine operators, programmers, and clerical and administrative personnel. The user's interest is getting his problem solved in the quickest possible way. If a user consults with a programmer or a consultant and he is informed of a procedure to solve his problem which is much more complex than necessary, the user could unnecessarily experience frustration in completing his task. Likewise, if a change affecting the user population is implemented to the system and this change is not communicated to the users, then user relationships can again be adversely affected.

Whether a University computing center is large or small, the following provisions seem to be a minimal requirement:

- job submittal station.
- user education.
- software development and maintenance.
- creating an awareness of service.

This list although not all inclusive should be representative. Most computer centers operate in both a batch and an interactive environment. In a batch environment, some means is provided for submittal and processing of student and faculty jobs. A University computing center may operate upon an open shop basis, a closed shop basis, or a combination of both. If an installation operates on a closed shop basis, then user submittal procedures are somewhat simplified. A user simply submits a job to computer operator or clerk who handles the processing of the job. As a minimal requirement in an open shop, the user needs to know how to operate a card reader and possibly a printer. Both types of operation have advantages and disadvantages relating to personnel, supplies, and costs. However, each approach implies a certain level of service to the user.

User education is a continual process. New student and faculty users are continuously using the computing facilities. Because of this factor, some degree of education regarding computing facilities must be provided. This can be generally handled through orientation seminars or special group meetings. User education should also be directed to established users. These users may represent a number of disciplines involved in different types of research and course development. As software advances are implemented, these users need to be informed as to how their work is affected or how their computing can be enhanced with these new implementations. In addition to regularly scheduled seminars, user education can extend into the classroom to acquaint students and faculty with various packages relevant to their course of study. There are also special interest groups which can benefit from similar instruction and "hands on" experience.

Likewise, software development is an ongoing process for the University computing center. Updating and modifying existing software is an integral part of providing computing service. The development and implementation of new software is a necessity because of instructional needs, faculty research, and course development. Many application packages, compilers, and other software are continuously in a state of improvement and enhancement for the user. There are new systems continuously under development for instructional applications. Computer-assisted-instruction, computer graphics, and other computer based education are areas subject to constant change and development. While a computer services organization may not have the staff to produce new application packages, many new application packages can be obtained for a nominal fee particularly if the application package is produced by another university or college or university affiliated agency.

The last provision enumerated, creating an awareness of service, although not mutually exclusive of user education, nevertheless deserves some special attention. University computer centers need to be encouraging new users as well as servicing the established users. Whereas user education addresses the instructional needs, there is the broader function of assisting those faculty and students who are not currently users to become computer users or potential users. There are probably many tasks which are performed by faculty that could be done more efficiently via the computer. Some of these tasks which represent standard applications are testscoring, generation of mailing labels, course evaluation

processing, data services, and other functions. New faculty and students arrive at the university every year. Some of the ways to publicize services is through the distribution of brochures to new faculty and staff, presentations on computer services at orientation meetings, and visitations to departments. Newsletter publications offer another media of communication as well as the production of user manuals.

While the present role of the University computer center seems to be well defined, it is nevertheless subject to change. As computers permeate the primary and secondary sectors of education, students enrolling in college will be viewing colleges from another perspective, the computing resources and applications for students. Likewise, new faculty who are being recruited for positions in disciplines where the computer is in use will be inquiring about the availability of computing resources/services for faculty research and other applications. Whether students or faculty, each will be wanting to gain access to certain resources. This factor alone will cause a continuing re-evaluation of any plans for providing computing services and the type of service to be provided.

In addition to the perceived changing role, a future role may find the University computing center assisting both pre-service and in-service teachers to utilize the computer in an instructional environment. How can the University computing center assist in the training of the teacher and thus provide a center may be considered a storehouse of resources--that is, hardware, software, and staff. In view of budget constraints, equipment costs are not in the affordable range of many school systems. Even with current technology, the installation of a suitable computing system can cost many thousands of dollars. Fortunately, in some instances, there are universities which are able to supply relatively low-cost timesharing service to schools. Some states such as Indiana and Minnesota have established a statewide instructional computing network. Second, the staff of the University computing center can perform invaluable assistance in educating future teachers and practitioners in the use of the computer. For the pre-service teacher, an adjunct to a methods course could be established to acquaint future teachers with the fundamentals of computing equipment and program development. Such a course of instruction would give the teacher a basic understanding of what a computer can do and how it may be used in the solution of problems. This course would also include "hands on" experience in working with CAI, simulation, and other related applications.

During the course of instruction, the teacher would program solutions to problems relevant to educational practice.

Additional future roles may find the University computer center interfacing to a greater extent with minicomputers and eventually microcomputers. These hardware technologies are here today but are certain to have a greater impact upon computing as the demand for services increases. There are educational applications well serviced by the minicomputer but there is also a need for the mini to have the capability to communicate with other minicomputers or a large scale central processing unit. It may even become necessary for the microcomputer to "talk" to the minicomputer. In any event the University computing center is sure to become a system of computers which may be a part of a network of computers. This will have strong implications for levels of services to be provided, flexibility available to the user, and new staff competencies.

MANAGEMENT OF THE DATA PROCESSING FUNCTION

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The need is established for the inclusion of a course in Data Processing Management in the curriculum of the College of Business Administration. A specific course is outlined and described in sufficient detail to assist faculty members in the development of a comparable course. The major stress in the course is that, despite many new organizational concepts and its technical nature, the data processing function can be controlled by proven established techniques of management.

In the curriculum of both the College of Business Administration and the Computer Science program there is a notable lack of courses or subject matter covering the Management of the Data Processing Function in Industry. An examination of the courses offered in Computer Science shows that the emphasis continues to lean toward either software design and development or hardware design. Strangely enough the Business Administration College rarely participates in the Computer Science program, yet the Business graduates will encounter the impact of the computer soon after entering the business world. Why is this the case?

It is very difficult to explain this situation but some ideas will be given which taken in combination could possibly be considered a reasonable explanation. For many years the curriculum of the College of Business Administration has placed an emphasis on such areas as Accounting, Finance, Marketing, Economics, and Management. None of these areas has put any stress on the use of the computer, particularly as the subjects have been taught by faculty members not trained or versed in the use of data processing. The approach to teaching the subject matter has not required or involved the computer. How does this technique impress the students concerning the use of the computer? Students could say, "It is not important to my general knowledge to tie the ideas together because the computer was not used in my regular courses." The way in which many subjects are taught will not impress the student that the computer is important in the business world.

Quantitative Methods courses do provide a greater opportunity to utilize the computer knowledge that could be used to great advantage. This may be due to limited computer background of the teachers, or insufficient time to include computer techniques for some students who may need a refresher. A real commitment to require and use computer programming knowledge in Statistics and other Quantitative Methods courses would help alleviate this situation.

In many Business Administration Colleges beginning courses in "The Introduction to Computers in Business", are taught with a dual emphasis on learning about the capabilities and limitations of the computer along with some limited amount of programming and software techniques. Such a curriculum requirement is good, but without any followup and use of this knowledge in succeeding courses, the requirement has very limited value. Many schools offer a course Involving Business Applications in which the students learn the COBOL language and data processing techniques. However, unless such a course is part of the required business background, few students will take the programming course which will give them a better understanding and appreciation for the computer as used in industry. Because most companies with a computer have most of their applications written in either RPG or COBOL, it seems that classes that teach these languages must be a requirement for a Business major.

Another approach is to provide an infusion of faculty members who have the training and background in computer technology.

These people can provide the stimulus to both offer computer related courses and modify existing courses to include the use of the computer. An additional benefit can be gained through such new faculty members when they develop and offer computer seminars to the other Business faculty, so that everyone can make use of the latest technology. This approach takes time to implement and will seldom result in immediate benefits and improvements. The guidance and direction for an emphasis in data processing techniques rests with the Dean or the Department Chairman. Without such leadership the Business Administration College will remain with a dated curriculum which does not truly reflect the real world situation that the Business graduate will soon enter.

Still another possibility is provided by the example set by a university which recently established a faculty committee to examine the possibility of developing and offering courses in Computer Science. The unique character of the committee was that representatives from Engineering, Mathematics and Business were major contributors to the curriculum proposal that was developed. Here we see that the Business Administration College was included in the discussions and, in fact, was able to show the Science and Engineering members that Data Processing Management was not only important in the Business curriculum, but also needed in the Computer Science core requirements. The cooperation between the three departments constitutes a strong relationship in recognition of the importance of all programs relating to data processing or computers. Three options are provided to students that permit them to take a major emphasis in software, hardware or business management of computers. In addition to the major in Computer Science with a choice of option, the new Computer Science program strengthens the curriculum in other subject areas by allowing a student to take a minor in Computer Science or Data Processing. Many of the courses required in this program already existed in the curriculum, so now they can be collected into a degree plan that many students have desired for some time. This cooperative effort strengthens the background of Business students because more data processing courses can be taken and a special emphasis in Data Processing Management is now possible. This new curriculum development provides an opportunity for students to have an improved college background in preparation for their careers in industry. A combination of these ideas can be used in the Business College to prepare college students for the real world in industry.

On the opposite side what is the attitude of industry toward the educational preparation of the new college graduates that are hired? There are two categories

that provide a possible way to determine the special attitudes. One part concerns the company representatives who are familiar with the data processing activity and the other area deals with the actual workers in data processing who are recent college graduates. To obtain an answer to the first category, a survey is currently in progress to determine data processing management's feeling toward the actual background and capabilities of the programming and operations staff. Results of this survey are not yet available, but it appears that several specific courses relating to data processing management ought to be included in the students business background. For the second category, there is considerable evidence that college graduates in business in recent years have not always had all the background that helps them with their company jobs. Many workers have returned in recent years to take additional computer-related courses offered by the university. The COBOL course has had a sizeable enrollment of currently employed data processing workers. While talking with these students one finds that many want the type of courses most frequently found in a Computer Science curriculum, because such courses have a much closer link to the nature of the work they are currently performing. While the Data Processing Management course has not been mentioned as often as programming courses, it is understandable because that course has just entered the curriculum at the local university. The career students recognize the value of the new course and plan to take it soon. Thus it is considered useful in the long term, but not needed immediately as much as programming and systems analysis material.

With this background establishing the need for offering a course in Data Processing Management, it is worthwhile to examine the course in some detail and indicate how it relates to existing Management courses. One of the first considerations for this class is to determine what sort of background a student should have. There were two major aspects considered that would provide a reasonable requirement. One area concerned the formal course work that a student should have and this included a beginning course in Management, and secondly, a course that required designing and executing programs written in a programming language, such as COBOL. This latter course is one step beyond a general introductory course which traditionally has provided an appreciation for the computer and its capabilities, but only a superficial knowledge of programming and the software development process. A knowledge of the programming process is needed to provide some understanding of how the computer operation activity is run and, at least give the student a minimal acquaintance with the management of the data processing center.

On the other hand, there are many students who are working in industry who would have experienced first hand the data processing function and would have had numerous interactions with management. Either the group of classes or the work experience should provide the necessary background for entering the Data Processing Management course. It is very important that these prerequisites be strictly adhered to or it soon becomes apparent that inadequately prepared students will have difficulty in understanding many of the topics that are covered.

The specific contents of the course are listed showing the topics covered and then each one will be described in some detail.

1. Location of D P in the Organization
2. The Organization of the D P Function
3. D P Planning and Change
4. D P Techniques and Special Tools
 - A. Systems Development
 - B. Project Management
 - C. Scheduling Techniques
 - D. D P Standards
5. D P Personnel Management
6. Management of D P Operations
7. Equipment Evaluation and Selection
8. D P Cost Management
9. Evaluation of the D P Function

The location of the D P Function within a company tells many things about the organization. One aspect relates to how long the company has been involved with the computer, another is its size, and still a third item deals with the major user of the computer. When starting out with its own computer, many companies have placed D P in that part of the organization where the main applications are located. This has been frequently in the financial area with Payroll being the first application to be run on the computer. Such location is not without its drawbacks as other sections of the company have developed computer programs and have requested better service than they were receiving. As the computer service expanded and more users were scattered throughout the organization, it became more and more important that the location of the data processing function be where its service could reach out to all parts of the organization. Thus there has been a trend to place the computer department higher in the organization where it could provide better service to all.

The Data Processing department is made up of both some traditional organizational principles and others that are unique to D P. The objectives of the activity must be recognized along with the environment in which the D P activity is placed. There must be clearly defined lines of authority and the related reporting structure. There should be open lines of communication both within D P and with users outside D P. Each manager's span of control should be of appropriate size to be effective. Functions should be grouped to make the most economical and effective use of manpower and equipment. These concepts are common to the organization of all activities. However, there are some unique characteristics contained in the data processing function that require special attention. Data processing, as a technical operation, requires a unique blending of technical and managerial skills. As a service organization, data processing must integrate operations across organizational lines and maintain good communications with all users. The special organizational concepts that the data processing department is concerned with include:

1. Locate the D P activity to provide quality service to all users.
2. Maintain contact with user departments to remain up-to-date on D P applications.
3. Recognize the need to concentrate and encourage technical knowledge and experience.
4. Recognize the need to keep current with the state of the art and emerging standards in the organization.
5. The organizational structure should place sufficient importance on planning, scheduling and control activities.
6. Developmental and operating responsibilities in D P should be separated to permit suitable management controls that relate to their unique activities.
7. The D P functions and responsibilities must be organized to prevent individual control over information being processed.

Another organizational consideration for D P is the issue of "Centralization vs Decentralization" and there are numerous advantages on both sides. Perhaps the greatest factor in attempting to answer this question is the size of the company followed closely by the nature of its business. Thus it depends on many considerations in order to formulate the

appropriate organizational structure.

Planning is a vital part of the data processing function and is made up of many activities. In practice a company that may be considering adding a computer department to its organization is well advised to study all of the effects of such a change and develop a group of alternatives so that a good decision can be made based on the most appropriate choice. Through the use of a feasibility study all the factors that contribute to the implementation of the plan can be examined in sufficient detail so that many problems can be anticipated and avoided during actual installation. The systems approach provides a good framework on which to base the planning activity. One variation of this approach divides the activity into three major categories:

1. Problem Definition and Organization
2. System Analysis and Development
3. System Evaluation

Each of these group headings can be further subdivided into activities that need to be performed in order to achieve the overall mission. Problem definition involves identifying the problem, analyzing the environment and characteristics of the problem, and developing the organization needed to achieve the stated goal. This category is followed by analysis and development activities that include identification of objectives and measurable goals needed to solve the problem, determination of what is to be done and in what order, including descriptions of various alternatives, and then selection of a method and development of a prototype. The final step of evaluation can be satisfied by testing the developed model, analyzing the results of this test, making modifications wherever necessary, and through appropriate measurement determining that the overall mission has been achieved satisfactorily. One of the most prominent features of the systems approach is that there is provision for feedback in the system that allows revisions to be made to help improve the system. This feature, while not specifically stated in the general activities, makes this approach a dynamic system in a real-time sense. Frequently the computer is made a part of the loop so as to provide immediate feedback and correction. Planning based upon this technique allows for change, which is so frequently encountered in data processing, and can be applied to organization, software development, personnel, financial, or equipment planning.

One tool that is readily accessible to the data processing department is the computer itself and it should be used to its fullest extent. A number of programs have been

written that are of great benefit in preparing and implementing a planning schedule. Such techniques as the Critical Path Method (CPM), PERT, production scheduling, programming scheduling, and budget programs, can assist with many of the D P activities. In addition there are numerous charting techniques that aid a planner or manager in keeping track of scheduled activities on a timely basis, so that management knows exactly where each activity or project stands. In most data processing departments there is usually a group concerned with the development of new computer applications. Once a project has been defined it is necessary to develop the total plan and schedule so that progress can be monitored. This type of activity is usually referred to as project management, and again computer programs provide significant aid in planning and tracking the various activities that are required. A very important part of the D P activity is the establishment of a set of standards for the variety of methods and procedures that are a part of the whole data processing department. This includes the management control area, operating procedures, programming activities, project control procedures, maintenance requirements, data security, career development, and many other D P activities.

Personnel management in the D P function requires a skillful blending of technical and management capabilities. There are large numbers of people with highly technical knowledge in the data processing department and these people must have the opportunity to constantly update themselves in their special areas. The changes in both hardware and software and related techniques that have occurred in recent years pose a serious problem to all D P department personnel just to keep up with the new developments. Operations people require special education and training whenever a computer system is changed. This applies equally well to changes or upgrading in both hardware and software. The change of the Operating System that runs the computer activity has always been a difficult period for the entire D P staff. Prior programs do not always run satisfactorily with the new or modified system, and there is usually a shakedown period needed to get the operations section running in the same smooth fashion as before the change. Such transition periods are a fact of life in D P, for which there must be sufficient education and training of all affected personnel, not only those in D P, but also all of the various users of the system. Because of the special technical aspects of D P, it is very important to develop job descriptions for the types of positions to be filled. Many of these jobs have similar requirements but with a different emphasis, such as application

programming, operating systems knowledge, and systems analysts activities. Along with these descriptions it is necessary for each manager to write out and discuss with each employee the expected activities and performance required of the individual. This provides the basis for evaluating each person at the end of the appraisal period, most frequently one year, and again they will discuss how well the individual measured up to the expected performance as observed by the manager.

D P operations management has some unique characteristics because there is usually a two or three shift operation that must be covered by experienced personnel. This shift work also presents a need for a regular training program because operator turnover can be high, because it is one of the less technical jobs in D P. Another activity involves the scheduling of work flow through the department, and this may require some delicate decisions in assigning priorities to keep all users satisfied. Still another vital activity is the arrangement of work to have good machine utilization with improving efficiency. Most of these activities require the collection of statistics to provide the appropriate control of all operations. This information helps to show the utilization of equipment, the activity of people, the performance of the system, and to give management a comparison with figures for previous months or years.

The selection of computer equipment depends very much on establishing the criteria to be used in making this decision. There are many considerations that should be evaluated when attempting to analyze all the information that can be gathered about computers and their capabilities. Among these are price-performance, throughput, room for growth, reliability, languages and operating systems available, application programs, special routines available, maintenance costs, variety, speed and cost of the equipment, ability to attach other devices, etc. Emphasis should be placed on the successful running of benchmark programs that truly represent the major characteristics of the current D P activity. In the evaluation, management should not overlook the importance of the software in making the selection. If there is to be a conversion from one type of hardware to another, this changeover will require significant parallel operation to determine the suitability and reliability of the new equipment. If there is an added requirement of a software change in either operating system available or in languages to be used, there would be a longer conversion time needed to rewrite many of the programs in the new language or use an emulator to assist with the conversion. This latter activity only delays the

time when programs will have to be rewritten. Such programming efforts usually take longer than the planned time, so ample lead time is needed.

The data processing department can be considered a costly operation when compared with other operating departments. This is due to several factors, such as the equipment, the need for many highly skilled technical people, an operation that may run 24 hours a day, additional costs associated with developing more applications to put on the computer, and education and training costs. Most of the above items are recurring costs that are relatively inflexible. There would not be a great variation in them unless a significant change occurred, such as updated equipment. In the development area, the costs occur only once for a project, so that development work should be carefully reviewed in advance of the implementation of a project. The development work, which is a special activity, could be contracted for outside the company with some possible savings. This, of course, is a management decision, which requires sufficient supporting evidence to permit a correct decision. There is another area in which costs, from a company standpoint, might be handled in several ways. This pertains to the cost of the hardware and maintenance, which can be purchased, leased, or rented depending on company requirements.

Evaluation of the D P function should be an ongoing activity. Where a company develops a plan for establishing a D P department, the last step should be to evaluate the new installation to make sure that it is performing up to expectations. If it is not, corrective action should be taken so that the original goal can be attained. The same evaluation should be a part of systems development or project management activity to determine at the conclusion of the development effort that the goal of the project was truly reached. The management level that made the decision to establish a D P department will certainly want regular progress reports on the activity, to be certain that it was a wise decision and also to know how successful D P is serving all users and the company.

A final word on the way the course is presented and the availability of course material. There are very few books available that cover all or most of these topics, so an extensive reading list of books and articles that relate to the topics covered is provided. Students pick a book and several articles on which to make a report to the class. Examinations can be used to allow students to develop their analytical ability.

MICROPROCESSOR-BASED INSTRUMENT AS A PERIPHERAL DEVICE

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The basic requirements for interfacing to an intelligent peripheral are reviewed. An outline of both hardware and software requirements is presented for an instrument designed with the Intel 8080A microprocessor. A microprocessor-controlled electrophysiological stimulator is presented as an example of the techniques used in one particular application. The relative merits of hardware counters used as timers compared with software timing loops are discussed.

Interfacing to an intelligent digital instrument is not very difficult, but it does require consideration of some subtle details which may not be commonly understood by scientists. In any interfacing problem one must determine the number and types of inputs or outputs necessary, but beyond this the choices become a bit more specialized. The following questions outline important decisions which greatly influence the success of interfaces.

1. Are data conversions required at the input or output ports?

In scientific instruments the answer is likely to be yes. An analog-to-digital (A/D) conversion may be required at an input, or a digital-to-analog (D/A) conversion at an output. Surprisingly, the interfaces are basically not determined by the type of converter selected, but primarily by the mode of data transmission chosen.

2. Is digital data to be transmitted in serial or in parallel format?

Practicalities usually limit remote data acquisition to serial format, while nearby data gathering or high sampling rate usually dictates parallel format. The serial transmission is greatly simplified by using a device called an universal asynchronous receiver/transmitter (UART), which is offered as a standard pin-compatible part by several suppliers. No such standard exists for parallel format. Most microprocessor chip manufacturers offer a device called a programmable peripheral interface, programmable interface element, programmable interface adapter, or some other brand name. The resultant action of these devices is so similar that they form a *de facto* standard for parallel transmission.

3. What data sampling rate does the interface require?

Scientific applications pose such widely divergent data-rate requirements that this rate often determines the type of data converter to be used and sometimes the transmission format as well. Sample times can range from hundreds of milliseconds to a few microseconds.

4. What accuracy must the data converter maintain?

This choice fixes the number of bits which the converter must encode. Approximately, 0.5% requires 8 bits, 0.1% takes 10 bits, and 0.025% takes 12 bits.

5. Which type converter is best?

This selection involves several trade-offs, and the choices are summarized in Table 1 below.

6. Can the microprocessor (MPU) be used in the conversion process?

If an instrument includes an MPU it is important to fully utilize it. Given adequate time, an MPU can emulate almost any hardware design, but remember that each instruction takes 2 to 4 μ sec to execute. For slow conversions the MPU is very efficient; and with a single hardware setup the software permits changing from a successive-approximation A/D to a tracking A/D. As a rule of thumb, software should be substituted for hardware whenever possible. The limited speed of the MPU, however, makes software feasible only for conversion times greater than about 50 μ sec. If multiple channels are being encoded or decoded, the processor must be shared among them, further compounding the speed limitations. On the other hand, D/A conversions can usually be accomplished with software alone.

Table 1. Summary of Converter Characteristics

Type of Converter	Relative Cost	Conversion Time			Sample Hold	Duty Cycle	Commercial Availability
		8 Bits	10 Bits	12 Bits			
Integrating	Low	20 ms	30 ms	40 ms	No	100%	Yes
		0.3 ms	1 ms	5 ms			
Tracking	Low	0.2 ms	0.25 ms	0.3 ms	No	100%	No
		2 μ s	2.5 μ s	3 μ s			
Successive Approximation	High	30 μ s	40 μ s	50 μ s	Yes	50%	Yes
		0.8 μ s	1 μ s	2 μ s			

7. What software interfacing scheme is appropriate?

The operating mode of the converter affects both hardware and software. Since D/A converters are generally easier to interface than A/D converters, this discussion will be limited to the latter. Two types of interfacing techniques are commonly used. The simplest conceptually is the interrogate-and-wait-till-ready approach. The method involves only polling of a status word, but it is limited to use with an under-utilized MPU or a fast A/D converter. The method is also limited to non-multiplexed single-word interfaces.

Most interfaces, however, require interrupt capability. Three general types of interrupts are common--(1) direct memory access, (2) non-vectored, (3) vectored. Direct memory access (DMA) is a non-processor interrupt which exercises control of the MPU bus during one or more cycles or even during a portion of a cycle. Data transfer from peripheral directly to the MPU memory is handled by external hardware. The comparatively large amount of external hardware required discourages the use of this method, but transfer speed favors its use. Several MPU manufacturers have recently announced LSI chips which incorporate the hardware necessary to control one or more channels of direct memory access.

The non-vectored interrupt causes the MPU to stop after the current instruction and jump to a predetermined location. This location contains a routine both to save vital status and registers, and to poll peripherals in order to ascertain which one requires service. After the peripheral has been serviced, the interrupt is cleared, the status is restored, and the MPU will resume its program.

The third type, called a vectored interrupt, causes the interrupting device to send out the address (called the vector) of its service routine at the appropriate time. Otherwise, it executes in the same way as the non-vectored type except that the polling scheme is not necessary. Notice that both non-vectored and vectored interrupts are basically software

techniques, because the actual data transfer is program controlled. Direct memory access may be regarded essentially as a hardware peripheral control with the MPU halted.

If the system includes several peripheral devices which may interrupt simultaneously, a priority system is required. The priority system must be implemented with auxiliary hardware. Some chip manufacturers provide LSI devices which include necessary hardware for priority decoding. Priority decoding hardware is unnecessary for the non-vectored interrupt, because the polling scheme establishes priority.

The particular design example selected to illustrate this discussion is a MPU-based electrophysiological stimulator and associated equipment. The basic functions required of the instrument are (1) generation of variable duration single pulses, (2) generation of variable duration dual pulses separated by a variable delay, (3) storage of accumulated input data, (4) manipulation of stored data, and (5) transfer of stored data to a mass storage medium. Only selected ones of these functions will be discussed, because they embody essentially all the choices mentioned above.

For the generation of variable duration pulses one may program an arrangement of software timing loops. The minimum timing increment for the 8080 MPU operating at a 2 MHz clock rate is 5 μ sec, and the minimum pulse duration is 10 μ sec for single pulses. When dual pulses are required (as, for example, in refractory period measurements), the minimum pulse duration is even longer. A 250-byte pulse sequence subroutine, written to include software selection of either dual or single pulses, provides a minimum duration or delay of 20 μ sec. The program can furnish durations and/or delays in steps of 5 μ sec to a maximum of 2.5 msec. Longer delays require more software and larger steps. Notice that for software generation of pulses no data converter (A/D or D/A) is required.

If the timing resolution must exceed the 5 μ sec increments provided by software

timing loops, one must resort to external hardware timing circuits. The implementation of one such hardware circuit is shown in the block diagram in Fig. 1. Two banks of decade down counters are preset to values of duration and delay, respectively, by the MPU, and then counted down to zero by pulses from a crystal controlled clock. When all the counters reach zero simultaneously, the four-input NOR gate produces a pulse to terminate the timed interval. By driving the control inputs to the counters from a decoder, the preset inputs and control inputs appear as ports to the MPU. The clock lines may be multiplexed from a multidecade divider to provide positioning of the decimal point.

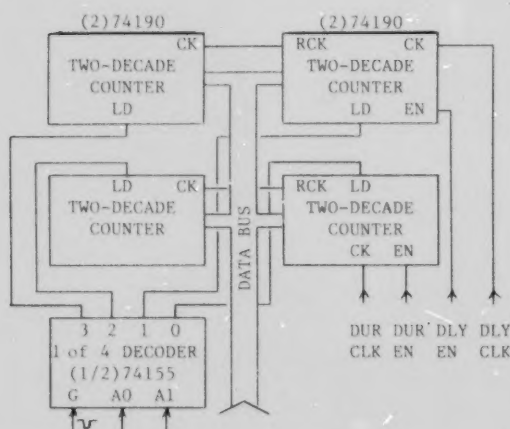


Figure 1. Diagram of Hardware Timer

It is interesting to note at this point that most MPU manufacturers have introduced some type of programmable interval timer (e.g. Intel's 8253 and T.I.'s 5501) which perform the above function, as well as other functions. These LSI peripheral devices are neither inexpensive nor readily available at this time.

The hardware timing circuit provides resolution to better than 0.5 μ sec increments with minimum delay and duration of less than one microsecond. This order-of-magnitude improvement compared to software is obtained at the expense of appreciable hardware. In this case a 250-byte subroutine is replaced by about a dozen TTL devices or by one relatively expensive LSI device.

The electrical output of a stimulated nerve or muscle preparation is usually of fundamental importance to the investigator of electrophysiological systems. The action potentials or myographic signals must be recorded for careful analysis.

The signals are often extremely brief; for example, the action potential in a frog sciatic nerve occurs in about one millisecond. Since analog-type recording instruments which can follow such transient signals are quite expensive, it seems reasonable to consider digitizing the signals and storing them in the MPU memory. The MPU memory can thus serve as temporary storage from which the data may be transferred to an inexpensive mass storage medium such as cassette tape.

This signal input requires an analog-to-digital converter. The short duration of the signals, however, requires a high sampling rate. If one desires 0.5% accuracy, the converter must provide eight bits. This word length is particularly easy to interface to the 8080 MPU used in this instrument. The sample time for the A/D converter should be about 5 μ sec for such a signal. Parallel transmission format seems best for such a short sample time, and the choice of parallel format means that the MPU must be located relatively near the A/D converter.

The converter selected for this application was the tracking type. This type has the advantages of low cost, no sample-hold required, and essentially 100% duty cycle. The lack of a commercial product is not a significant disadvantage, because Precision Monolithic has published a circuit design of a simple tracking converter complete with the printed-circuit board layout. Single copies of this layout were made commercially for about \$10.00.

The conversion time of good 8-bit tracking converters is about 2 μ sec, and only the successive-approximation converter is faster. The cost of the successive-approximation converter is relatively high for 2 μ sec conversion time; the cost of the required sample-hold module raises the cost even more. If a data latch is provided at the output of the tracking converter, the converter may be operated continuously thereby achieving almost 100% duty cycle.

The principal disadvantage of the tracking A/D converter, poor performance with noisy signals, was thought to be surmountable in this application. Typical electrophysiological amplifiers are of low noise design and provide significant signal preconditioning. This choice is one of the trade-offs mentioned.

For the 5 μ sec sample time found in this application, software control of the conversion process is impossible. A rather different approach was taken. Inadequate time is available to the MPU, operating at a 2 MHz clock rate, to provide both stimulator timing and conversion control. Consequently, a hardware-controlled 256-byte RAM buffer memory was included with

the A/D converter. A memory-address sequencer and associated control circuitry permit data acquisition at the high sampling rate required by this application.

An important advantage of the above hardware configuration is its capacity to serve as a DMA controller with a minimum of additional hardware. The addition of three TTL packages provides the DMA capability to affect a rapid dump of the buffer memory into the main memory. The circuit becomes a self-contained, high-speed data acquisition channel. The MPU software needs only to initialize and start the data acquisition or to request the buffer-memory dump. It is interesting to notice that the DMA-controller LSI chips offered by some manufacturers cannot provide buffer-memory control in addition to DMA, as does this circuit.

The block diagram in Fig. 2 shows the hardware implementation of the data conversion channel discussed above. The A/D converter encodes continuously the signal from the experiment, but the data latch samples and holds its digital output once during each memory address. When the channel is in the write mode, the MPU system bus connections are three-stated in order to isolate this peripheral from the system bus. The sequencer generates a two-phase clock for the circuit, and it uses phase-one simultaneously to latch data from the A/D converter and to generate the next sequential memory address. Phase-two writes the data from the A/D latch into the selected memory location. This two-cycle operation repeats until all 256 memory locations have been written.

When the channel is in the read mode, a hold request is sent to the MPU, which acknowledges by releasing system bus control to the peripheral. The sequencer then generates memory addresses for the DMA transfer from peripheral memory to system memory. Notice that the high-order address byte for the DMA transfer is set up in the address latch prior to the read sequence. The address latch is treated for this set up as a latched output port of the system, so the 256-byte memory block from the peripheral may be located by software anywhere in system memory.

The techniques used to interconnect the MPU based instrument as a peripheral device to a main computer are typically much more familiar to scientists than those discussed above. Ample literature concerning this interface has been generated by mainframe computer suppliers as support for their products. For this reason this discussion has concentrated on the interface between the instrument and the experiment. Literature concerning the instrument-experiment interface is scattered among many publications.

The computer-instrument interface is usually accomplished with a serial link using an acoustic coupler via telephone lines. The serial data exchange modules offered by Analog Devices are examples of commercial interfaces of this type. These modules cause the instrument to appear to the computer as a teleprinter; virtually every computer provides teleprinter ports.

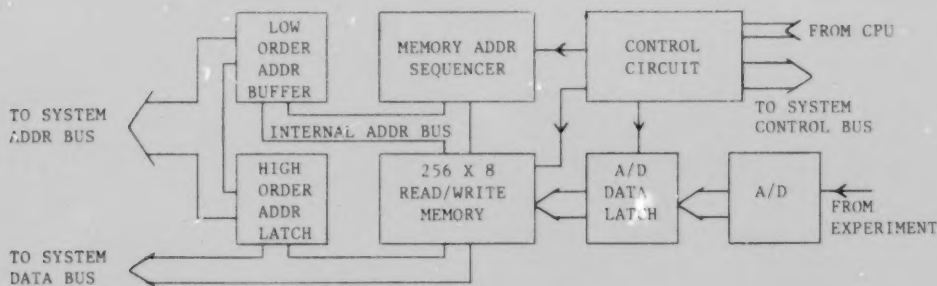


Figure 2. Data Conversion Channel

MOVING THE MONOLITH

Coordinator - Joy Belsky
Coordinator for Computer Based Education
University of Washington

Lowell N. Ballew
Computer Center Director
East Texas State University

Dr. J.J. Lagowski
Professor of Chemistry
University of Texas

"Moving the Monolith" refers to the enormous effort required to stimulate the various essential parts of an instructional institution to acquire and use Computer Based Educational (CBE) materials. There are a number of necessary conditions for any successful CBE program - faculty acceptance, administrative support, learning resource center skills, etc. The panel members will discuss the ways they are trying to achieve the acceptance and support at their universities and colleges and will note which activities have succeeded and which have failed.

Rising costs, reduced student population, and diminishing state and federal aid are causing financial difficulties for universities and colleges around the country. Even though many educators are interested in Computer Based Education (CBE) most schools are unable to locate even minimal funds for the purchase of new hardware and software to be dedicated to instructional use. Some schools however with their own financial constraints are launching long-term and expensive CBE projects. What are the main factors that cause administrators at one university to shift priorities and allocate money to a relatively new technique such as Computer Based Education while those at another university continue to ignore it? Can one or a few faculty or staff members affect such a change?

At institutions all over the country small numbers of enthusiasts have succeeded in establishing the need for CBE and in convincing Budget Committees and faculty members to give the idea a try. These innovators have used various strategies depending on the size, function, and financial base of their institutions. The three panelists for "Moving the Monolith", Dr. J.J. Lagowski, University of Texas, Lowell N. Ballew, East Texas State University, and Joy Belsky, University of Washington, have introduced or are now attempting to introduce CBE into their universities. Their strategies have been varied, but successful. Their techniques for moving their own monolithic institutions may provide strategies and ideas for others who are launching the same battle.

Joy Belsky
University of Washington

Computer Based Education (CBE) is expensive; it requires difficult attitudinal changes by instructors; and it hasn't been proven uncategorically to be effective. With these selling points, it is no wonder that school budget committees turn deaf ears to supplicants. At the University of Washington (UW) we in the Office of Academic Computing Services (OACS) have been studying the utility of different types of CBE, i.e. Computer Managed Instruction (CMI), Computer Assisted Instruction (CAI) and Computer Assisted Problem Solving (simulations/data bank use). We believe that all these programs are instructionally viable and effective when used properly and are now preparing to "sell" CBE to the faculty and administration. To increase the probability of success in bringing CBE to the University of Washington, we are continuing to do our homework and are trying to create a positive climate for CBE here on campus. By the time our proposal, a five-year plan for Computer Based Education, reaches the desk of the Budget Committee, the members will hopefully have heard about its diverse and positive functions, have seen it used in classrooms or in demonstrations, and be convinced that CBE is effective and is destined soon to be an important part of university education.

To create this positive climate we in OACS are organizing a many-staged program that we hope will lead to our general goal: CBE becoming an educational service of the University which fits into the usual allocation mechanisms.

Plan to Introduce CBE to the University of Washington

1. Perception of Need for CBE
2. Centralization of Planning
3. Focusing of Need
4. Channeling Need into Limited Action
5. Satisfying Need Through Long-Term Budgetary Procedures
6. Decentralization of CBE Activity

For an expensive, instructional program to be implemented in a research-oriented university of 35,000 students, large-scale planning is necessary. One-third of UW's operating budget comes from research grants. The University is having severe budgetary problems and administrators are reluctant to make room for any new programs which might mean the reduction of research programs.

The challenge of introducing CBE was taken on by the Office of Academic Computing Service, a department which oversees the operation of the Academic Computing Center as well as the planning and allocation of funds for all academic and research computing on campus. The rest of this paper will outline in detail the steps we are taking.

1. Perception of Need for CBE

It is sometimes difficult to determine if a need is real. Out of a faculty of 2,200, does one instructor who insists on CATC, two instructors who demand CAI and four instructors who write letters about grade management constitute a need compelling enough for the cancellation of other programs? We have tried to deduce the need for CBE in several ways.

- a) Survey of current use on campus
Individual instructors in twenty to thirty departments have managed to institute small-scale projects using departmental or research funds.
- b) Survey of instructors' attitudes
This yielded little real information since uninformed instructors were not willing to invest time for the initial development of programs or the restructuring of courses or habits.
- c) Requests for funds
In 1976, instructors requested \$100,000 for instructional use on one computer alone.
- d) Estimation of future demands for CBE
We determined that the demand for computing services, terminals, and interactive instructional computing would increase many-fold by 1987. It is important to plan now so that we will be able to fulfill future demand.

Having satisfied ourselves that the need for CBE was real, we concentrated on the second step.

2. Centralization of Planning for CBE

Although we have neither the facilities nor the interest to take on the function of providing CBE programs to instructors, the Office of Academic Computing Services decided that the project would benefit from centralized planning. Since a complete CBE program would require a large financial investment by the University, our only hope of gaining this commitment was (1) by careful study and planning and (2) by involving the entire University community.

3. Focusing of Need

Before we know what to plan for, we have to ask "What do the faculty and students need?" "Is CBE the answer?"; and "What are the necessary conditions for wide-spread and continued use of any program?" Many CBE programs have hit the dust because the above questions were not examined first. Our procedure has been to take the following steps.

- a) Investigate faculty need
This is hard to determine. We are presently measuring it by examining programs individually developed by faculty to meet their own needs.
- b) Investigate correspondence between faculty need and CBE programs
The way to disillusion faculty and administration about CBE is to provide programs that create more work than they eliminate or that offer services that can be provided in less expensive and complicated ways. When faculty demand computerized programs, we try to evaluate whether the programs will really satisfy their objectives.
- c) Investigate success at other universities
The history of CBE in American universities shows failures as well as successes. We spend hours on the phone talking to CBE program authors and users around the country trying to identify the successful and less-successful elements of educational programs.

This cautious approach puts a break on our program, but so far we have made no expensive mistakes; and we have considerable insight on which programs deserve our support.

4. Channel Need into Action

- A. Create a positive climate for CBE
 - a) We have involved faculty and administration in establishing and communicating goals for CBE by establishing a large study group to discuss CBE and smaller committees to propose immediate action in

specific areas.

- b) Faculty, students and administration have been informed about CBE through the publication of a general brochure on CBE, the publication of current activities in CBE on the UW campus, and notices in newsletters and reports. These publications provide recognition for active instructors as well as education for the community.
- c) The OACS assists interested faculty by providing administrative support and limited resources. Four portable terminals (teletype, CRT, and graphics) have been purchased to loan to instructors for two to six weeks for classroom use, demonstrations, or program development. We give small grants (\$25 - \$100) for special projects that need otherwise unavailable computer time. Finally, we help faculty identify interesting programs and then act as a liaison between faculty and other University departments, such as the Computer Centers, which often can aid the instructors.
- B. Write a Five-Year Plan for CBE to be reviewed by a faculty committee.

5. Satisfying the Need through Long-Term Budgetary Procedure

Although a large initial infusion of funds for hardware will be needed, we believe that Computer Based Education will continue to grow and funding must be stable. Our successes during the next five years must be substantial in order to persuade administrators to provide funding as they would for other standard educational materials such as library books and audio-visual equipment.

6. De-centralization of CBE Activities

We do not believe that CBE should be centralized in the Computer Center or in one Office of Computer Based Education. Funds will be distributed to learning resource centers, educational assessment centers, and to department heads for program development and use. This eliminates building another university bureaucracy and allows different groups to establish their own goals.

This plan of action, although on a financial shoestring, has already accrued some gains. There has been a noticeable reduction in faculty frustration by the knowledge that progress toward CBE funding is being made and by the accessibility of "loaner" terminals and small grants. Faculty and administrators all the way to Deans and Provost are becoming aware of the capabilities of CBE. There is less competition for limited funds and there

are fewer unconsidered demands for support as faculty come to understand the situation within the University. Our plans are on schedule and the climate for Computer Based Education is constantly improving.

Lowell N. Ballew
East Texas State University

Research into Computer Assisted Instruction (CAI) began at East Texas State University in September, 1968, when a faculty research grant was awarded the principal investigator, Lowell Ballew. This research effort, subsequently termed the CAI Project, received two follow-on grants over the next two years. The total of all grants amounted to \$35,834.

The project began with one major objective: namely, to determine the feasibility of using a general purpose digital computer on a time-shared basis for CAI. In pursuit of this objective, three subtasks were identified:

- 1) A comprehensive study of existing CAI systems.
- 2) Selection and/or development of a CAI software/hardware package suitable to the University's System 360 computer.
- 3) Development of a test vehicle in the form of a short CAI course segment.

Completing these three subtasks would, it was felt, place the researchers in a position to address the major Project objective.

Early project activity included correspondence with established CAI centers around the country and on-site visits to a selected few of these. Harvard, Florida State, the Philadelphia Public School Project, as well as several hardware vendors, were included in these visits. This activity provided the Project with first-hand information on a variety of subjects such as CAI staffing requirements, hardware configurations, costs, system reliability, and perhaps most important, on research currently being done.

By the end of the first year, a specific CAI system configuration had been defined and its major components, consisting of an author language, processor, I/O routines, a controller, and student/author terminals, had been selected. At this point testing of the selected system began at the IBM Data Center, Dallas, Texas. Testing continued for several months until the arrival in December, 1969, of the Project's first terminal.

In-house testing then began and, concomitantly, considerable effort was expended in the development of a suitable test vehicle--in fact, several course segments were developed. However, a course in elementary set theory was ultimately selected to be the test vehicle, and ex-

perimentation with bona fide university students began in the spring of 1970. The results of these experiments are contained in two published Project reports, titled, "Pilot Study on Sets: A Computer Mediated Course" and "Supplementary Study on Sets: A Computer Mediated Course."

In the year that followed experimentation continued, dealing with such things as terminal attributes, response times, instructional strategies, course development techniques, and student reactions to CAI. In short, the Project successfully put a viable CAI system "on the air" and in so doing, working-level expertise was accumulated in such areas as author languages, curricula development, and appropriate experimental techniques. The primary objective had indeed been accomplished! A plausible CAI system had been installed on the University's general purpose computer; and, although servicing only two study/author terminals, it was entirely feasible with regard to response time, degradation of shop throughput, provisions for curricula development, and manipulation of courses.

At the conclusion of the two-year grant period, the Project recommended that CAI activity be continued on an experimental basis at East Texas State University for the following reasons.

- 1) It could easily provide enrichment and/or remedial instruction for a wide variety of courses--thereby making possible significant improvements in the quality of the regular classroom experience.
- 2) CAI could be used by faculty and graduate students interested in conducting research into various instructional strategies.
- 3) Perhaps most important, CAI could be incorporated into the University's teacher preparation program--thus insuring that teachers going into the field would have had exposure to this new approach to education.

The University subsequently adopted the Project recommendation and since that time funding has been accomplished through the regular budgetary process.

By September, 1972, faculty interest in CAI was no longer strictly experimental. A limited production role was envisioned. To implement this new role more terminals and a larger staff would, of course, be required. Recommendations were made to the Administration to: change the student/author terminals from typewriter to CRT types; increase the number of terminals to eight; make the CAI Lab operational from 8 AM until 10:30 PM daily; add a full-time systems programmer to the staff. These recommendations were approved.

There are several advantages associated with CRT terminals when related to CAI usage. They are considerably more reliable, less expensive, transfer data at a much faster rate, and they are quieter and

more readable. There were problems, however, associated with the decision to switch to CRT terminals. First, and most important, CRT terminal support did not exist for the author language (CWIIL). Therefore, a new I/O interface had to be locally written and installed on the system. This constituted a considerable effort because of some rather peculiar requirements of CAI. Then, after the new system became reasonably stable, reformatting of all existing courses had to be undertaken to fit the new medium. The conversion activity took approximately six months and was completed in late spring, 1973. Thus with the beginning of the 1973 summer term yet another role was added to the three already mentioned for CAI at ETSU--limited production.

Demand for CAI which had been slow to develop over the years, now developed with a rush. At peak periods during the Fall, 1973, semester some students found they had to schedule terminal time two-to-three weeks in advance of the desired date! Such high usage prompted the University to order three additional terminals for Spring, 1974, and three more were added in 1975. The total now stands at fourteen.

Interest in CAI at ETSU continues strong and shows little sign of weakening. It is significant to note that this interest is broadly based, covering several academic disciplines and practically all levels of university administration. Annually the administration budgets approximately \$70,000 for terminal hardware and CAI personnel and, in addition, provides unlimited access to the host computer. It is also important to note that the University receives no outside funding for this operation.

By almost any measure CAI must be termed a success at ETSU. Perhaps this success is due in part to ETSU's operational philosophy. For example, individual faculty members are never left to their own devices in developing new courseware or discovering appropriate curricula materials from other sources. The CAI Coordinator maintains a very active interface with the faculty and with other institutions around the country and is thus in a position to offer ideas and assistance to anyone desiring to implement a CAI course. Another significant example of this philosophy is the continuing in-depth technical support accorded ETSU/CAI. Systems personnel have implemented automated student registration procedures, developed comprehensive instructor reports, improved system responsiveness and stability, and recently added on another authoring language (BASIC).

Of course success would not be possible without the strong administrative support mentioned earlier. In a larger sense however, such support merely reflects the depth of faculty interest in CAI and serves to underscore the commitment both these groups have to this approach to education.

J. J. Lagowski
The University of Texas

Recent experience at the University of Texas has provided the basis for discussing (examining) some of the elements for the successful implementation of Computer-Based Education (C-BE) at institutions of higher learning. Project C-BE was a four year effort, jointly sponsored by the University of Texas and the National Science Foundation, to implement computer techniques in a wide spectrum of undergraduate courses.

Before Project C-BE was undertaken, many questions had to be answered and the basic groundwork had to be laid. A pilot project was necessary; therefore, a chemistry course was developed which heavily utilized C-BE techniques. The course was highly successful in terms of student achievement and faculty time saved. Armed with these results, a team of four educators began their search for interested faculty members. As a first step they approached the deans for permission to discuss the Project with the departmental chairmen, who in turn gave permission for the team to attend faculty meetings and present their case for C-BE. The results of this work netted a number of faculty members with enough interest to dedicate time and effort to restructuring their courses, writing materials, and developing a grant proposal.

On the basis of this widespread interest, The University of Texas and NSF allocated a total of \$3,000,000 to the Project. The broadly defined goals for the Project were to

- 1) Define the common concepts of C-BE,
- 2) Evaluate C-BE methods,
- 3) Develop a fiscal model for C-BE, and
- 4) Investigate the transferability of C-BE methods.

The funding included \$1.6 million from NSF to buy terminals and to hire programmers and educational consultants. The University contributed \$1.4 million for faculty release time and computer time.

The entire Project has been successful with 27 courses developed in 14 departments of 5 colleges. The courses have utilized a large number of C-BE techniques: simulation/modeling, tutorial/drill/practice, computation aids, generated and scored tests, data acquisition and analysis, and computer augmented lectures.

A full description of the Project can be obtained at the meeting or by writing the author.

SLIDING INTO DATA BASE
GENTLY BUT SAFELY

Glenn B. Harvey
Director of Computer Services
DePaul University

Data base can be a frightening, organization-shattering experience. For some, it can be fatal, because it is often a course embarked upon with only vague understanding. Its centralizing effect on organization structure and policies can have bitter repercussions. This suggests a gradual approach to data base may be best to follow. But how does one go about it? How can older systems currently in production co-exist with new application systems under data base development? This paper presents one institution's solution to this problem.

Management Control - The Great Search

As managers, we all seek to control our resources, those men, material, machines or money under our jurisdiction in spite of changes that constantly arise, often unavoidably. Most of our energies are directed to that task of adjusting and correcting so that performance will comply with plan, the essence of control. This is the hub, the core, of scientific management as studied and taught by Frederick W. Taylor many years ago. It is reflected most notably in the exception principle ranging from Shewhart's Control Charts in manufacturing quality control to the establishment and execution of top corporate policies, each a standard against which actual performance is measured. It is clear that American business has prospered by using these techniques, evidenced by its growth and profitability.

Yet, somehow, computer service has managed to fumble through the last 15 years or so with little visible progress in controlling the development, implementation and operation of application systems in a flexible, cost-effective manner. Oh, many can claim advances in one form or another. Some have improved upon the control of projects...able to predict within 10% the time and cost of meeting task completions. Others cite improved programmer productivity where daily lines of code are up by several orders of magnitude. Still others can show improvement in managing the vast program libraries or the army of programmer analysts that had to be created.

Often, the solution to problems created by changes is to apply brute force, more programmers, more computer hardware, more cost. As though users can be satisfied with better application systems by simply applying more bodies and dollars. This approach has not worked out. Witness the impact of the technique called data base on the computer community. There was a flurry of activity several years ago when data base packages were first announced. It was offered up as the best way to achieve true productivity from computers, in a user's perspective, by sharing a common pool of data rather than individually-controlled user files. We started to realize that people costs were outstripping hardware costs and data base promised a significant reduction in re-programming because data could be made independent from programs.

What has happened with this idea? Why are only 5% of all computer shops using data base? Of those who do, what is the experience over the last 4 - 5 years? Has it paid off? Lower costs for people or hardware. Has computer staff grown? More satisfied users? Is it possible to relate and retrieve data now that could not be handled before? Can it be done easily, cheaply and when it is needed? Can the data base system readily accommodate changes that occur to application systems and data?

Entry Into The Unknown

Honest answers to the questions above are hard to come by. Many data base installations we know have had great difficulty applying the new technique. In most cases costs have soared for both people and

hardware. Even then, it is hard to see how the new systems respond readily to new needs, new demands, new changes. Everyone seeks a better way. Most computer service managers will agree that their control over changes is much less than they would like and that their lives would be easier if a better way to exert control could be found. Many, of course, have been developed, advertised, installed and used with great shouts of success. These include retrieval systems, query packages, operating systems, compilers and pre-compilers, file access methods and generalized systems.

At DePaul University, we examined many such systems, back in 1971. The data base package selected was TOTAL because of its low cost, minimum memory requirement, and well-established market position. But, TOTAL did not appear to offer the answer to changes, without some additional control apparatus...perhaps a new layer of software between the data base package and the application program. We had read about data element dictionaries and table-driven systems. These ideas appealed to us, but we had misgivings over our ability to develop them into reality.

While investigating TOTAL, we learned of its use at Amherst College in Massachusetts. Amherst had developed an embryo generalized maintenance & retrieval system using TOTAL for the disk data base. It was a dictionary-driven system that worked well. We elected to build the DePaul data base with the foundation provided by the Amherst systems. This approach to computer service was more state-of-the-art, responsive and flexible than any other we found.

Considering the big boost Amherst provided, the better way sought at DePaul had to meet additional goals. Ours were perhaps a little broader, more mercenary, more 'blue sky' than others might have been. We recognized our own peculiar problems, but also those of other shops with which we were familiar. We also had that kind of stubborn determination that comes from thinking you can build a better mousetrap. In any case, we created new software which we call an 'Application Control System' (ACS) that was meant to be:

- * Responsive - To changes in user needs regardless of timing or source of change
- * Flexible - Able to provide for new files, new data in old files, new methods of processing old data, entire new systems, etc.

- * Simple - Easily understood by users of data, and computer technician.
- * Self-documenting - Should provide relatively complete documentation of application systems as a by-product of its own operation.
- * Parameter-driven - Most functions to be handled by entry of control cards or tables with tailored programming held to a bare minimum.
- * User-controlled - User should have high degree of control over his own data files, their content, maintenance and usage.
- * Easily-converted - Able to interface easily with existing systems not under data base structure.
- * Economical - All of the above goals should be possible on relatively low-cost computer hardware with small memory. Staff expenditures should also be minimal yet able to concentrate on analysis, not programming.

Initial hardware for the ACS was an IBM System 360/30 96K memory, 4 tapes & 3 2319 disks. This was later followed by the current IBM 370/135 192K 3 tape/10 3340 disks as specified in our 1971 Master Plan for Computer Services. Installed since Feb. 1973, and to be replaced by a 370/138 512K machine in Feb. 1977, our 135 provides services for administrative users thru-out the university. The data base system, including ACS, has been fully operational for over 4 years and we would term it an unqualified success.

Application Control System

The DePaul Application Control System can be called a Data Management System, by some definitions. It is composed of four basic parts:

- * Generalized Maintenance System (GMS)
A single batch job stream. Handles maintenance of any & all files in data base. Transactions (documents) entered are broken down into their component data elements which are then edited, updated to the appropriate data base file, logged and reported out to user offices.
- * Generalized Retrieval System (GRS)
A single batch job stream. Can retrieve from any part of data base to satisfy report needs. It develops output record stream(s) that may be manipulated via sort, merge, match before printing in desired format.

- * Generalized Teleprocessing (GTS)
Two COBOL programs. First performs abbrev. version of update function in GRS above - includes full capability to examine, add, change or delete from any part of data base. Second program performs abbrev. version of GRS above - output record stream is displayed at the terminal and any type of search is possible.
- * Generalized Utility System (GUTS)
A single batch job stream. Can manipulate files (data sets) and their linkages (relationships) en masse to easily and quickly alter the data base construct to accomodate new files, new links, expanded record capacities per file, larger record sizes, etc.

Less than 15 COBOL programs constitute the entire ACS above. Simplicity is stressed thru-out the system. Tailored programming of special application details is typically all the coding need-

ed to bring up a new application system, along with several parameter sets that are entered to Control Data Sets. Even such tailored programming is done within a skeletal framework of an existing program and usually requires less than 2 weeks for the most difficult task.

Basic program functions in ACS are shown in Figure 1. These 15 programs thus become the fundamental basis for control. Their functions establish the standard for all data base operations in the shop, the core around which all application systems are constructed. Where data base elements, records or files are concerned, each of the programs seeks its specifications from a Control Data Set, not from its own Data Division. Since the specification in a control data set is separate from the program, true program independence from the data base is achieved in a real sense. In our ACS, the Control Data Sets (CDS) are stored in the data base like other data files, but they could be maintained outside that structure.

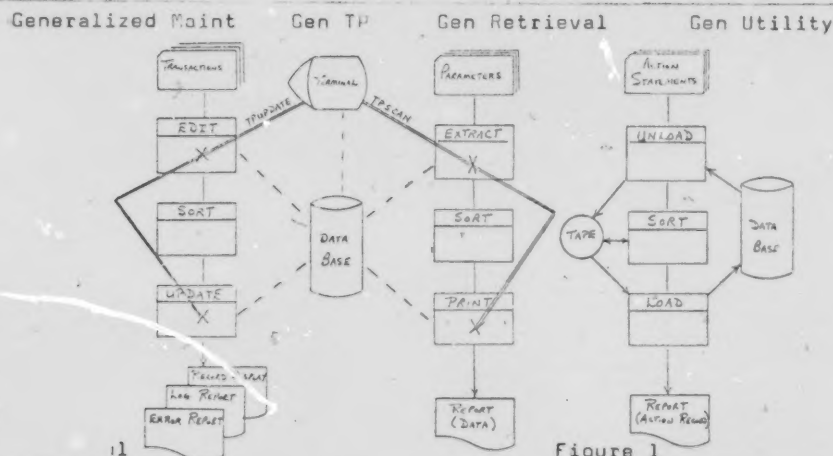


Figure 1

What are Control Data Sets?

A crude definition could be - files or data sets that contain tables of specialized codes (specifications) that can be used by a computer program to drive its own operation. This, of course, leaves much latitude. It can include compilers, interpreters and even program generators, not to mention data dictionaries. While any of these involve tables, only application-specific tables, like those found in data dictionaries, are considered in the DePaul ACS system.

This means that the Data Division of a COBOL program doesn't exist in the normal way...rather, just space for a table of codes or statements. Such a program

is dumb and depends completely upon directions received from the CDS tables accessed at execution time. Thus, data base 'binding' occurs at run time - the acknowledged best point to insure data/program independence.

Much interest currently exists in data element dictionaries and there is a growing awareness of 'active' directories which are simply dictionaries that function at run time - like the DePaul ACS. A more common type of dictionary is a non-active separate file(s) where element definitions reside. Additional benefits from the ACS approach include better documentation, single-source entry of application spec's and immediate response when element spec's are changed. And, of course, no compiling of programs is re-

DATA BASE DICTIONARY USER DATA FILES ** COMPRESSED **

ELM NO.	DESCRIPTION	C LOC	SEC LOC	FILE/SEG NAME	FILE TYPE	REC TYPE	EDIT TABL	SEC CL	MAINT DEPT	ALTERNATE UPDATE AND ACCESS	DEPTS
PE002	TEST VIEW OF PREV TN DATE	X	001	006	PEOPSEG1	N				000 114A	
PE003	ALUMNI CODE EXTRACT	X	005	005	PEOPCTRL	M				114	
PE004	LAST ACTIVITY DATE	N	001	006	PEOPSEG1	M					
PE005	PERSON'S ENTIRE NAME	X	001	040	PEOPSEG1	M					
PE006	LAST ACTIVITY YEAR	X	005	002	PEOPSEG1	M					
PE007	PERSON'S NAME	X	007	041	PEOPSEG1	M					
PE008	PERSON'S LAST NAME	X	007	010	PEOPSEG1	M					
PE009	PERSON'S FIRST NAME	X	007	020	PEOPSEG1	M					
PE010	NAME - MIDDLE	X	007	030	PEOPSEG1	M					
PE011	NAME - INITIAL	X	007	040	PEOPSEG1	M					
PE012	NAME - SUFFIX (DON'T USE)	X	007	050	PEOPSEG1	M					
PE013	NAME - ORIGINAL LAST	X	007	060	PEOPSEG1	M					
PE014	NAME - ORIGINAL FIRST	X	007	070	PEOPSEG1	M					
PE015	BIRTHDATE	X	008	006	PEOPSEG1	M					
PE016	ETHNIC BACKGROUND CODE	X	008	001	PEOPSEG1	M					
PE017	CITIZENSHIP/VISA CODE	X	008	002	PEOPSEG1	M					
PE018	RELIGION C OR OTHER	X	008	003	PEOPSEG1	M					
PE019	RELIGION STATUS - R OR S	X	008	004	PEOPSEG1	M					
PE020	APP - STATUS (LA, TU, AR, ...)	X	008	005	PEOPSEG1	M					
PE021	APPLICANT SWITCH	X	008	006	PEOPSEG1	M					
PE022	APPLICANT SWITCH	X	008	007	PEOPSEG1	M					
PE023	UNDERGRAD INDICATOR	X	008	008	PEOPSEG1	M					
PE024	GRAD INDICATOR	X	008	009	PEOPSEG1	M					
PE025	ALL ADMISSION INDICATORS	X	008	010	PEOPSEG1	M					
PE026	ADMISSION INDICATOR	X	008	011	PEOPSEG1	M					
PE027	ADMISSION INDICATOR	X	008	012	PEOPSEG1	M					
PE028	ADMISSION INDICATOR	X	008	013	PEOPSEG1	M					
PE029	ADMISSION INDICATOR	X	008	014	PEOPSEG1	M					
PE030	ADMISSION INDICATOR	X	008	015	PEOPSEG1	M					
PE031	ADMISSION INDICATOR	X	008	016	PEOPSEG1	M					
PE032	ADMISSION INDICATOR	X	008	017	PEOPSEG1	M					
PE033	ADMISSION INDICATOR	X	008	018	PEOPSEG1	M					
PE034	ADMISSION INDICATOR	X	008	019	PEOPSEG1	M					
PE035	ADMISSION INDICATOR	X	008	020	PEOPSEG1	M					
PE036	ADMISSION INDICATOR	X	008	021	PEOPSEG1	M					
PE037	ADMISSION INDICATOR	X	008	022	PEOPSEG1	M					
PE038	ADMISSION INDICATOR	X	008	023	PEOPSEG1	M					
PE039	ADMISSION INDICATOR	X	008	024	PEOPSEG1	M					
PE040	ADMISSION INDICATOR	X	008	025	PEOPSEG1	M					
PE041	ADMISSION INDICATOR	X	008	026	PEOPSEG1	M					
PE042	ADMISSION INDICATOR	X	008	027	PEOPSEG1	M					
PE043	ADMISSION INDICATOR	X	008	028	PEOPSEG1	M					
PE044	ADMISSION INDICATOR	X	008	029	PEOPSEG1	M					
PE045	ADMISSION INDICATOR	X	008	030	PEOPSEG1	M					
PE046	ADMISSION INDICATOR	X	008	031	PEOPSEG1	M					
PE047	ADMISSION INDICATOR	X	008	032	PEOPSEG1	M					
PE048	ADMISSION INDICATOR	X	008	033	PEOPSEG1	M					
PE049	ADMISSION INDICATOR	X	008	034	PEOPSEG1	M					
PE050	ADMISSION INDICATOR	X	008	035	PEOPSEG1	M					
PE051	ADMISSION INDICATOR	X	008	036	PEOPSEG1	M					
PE052	ADMISSION INDICATOR	X	008	037	PEOPSEG1	M					
PE053	ADMISSION INDICATOR	X	008	038	PEOPSEG1	M					
PE054	ADMISSION INDICATOR	X	008	039	PEOPSEG1	M					
PE055	ADMISSION INDICATOR	X	008	040	PEOPSEG1	M					
PE056	ADMISSION INDICATOR	X	008	041	PEOPSEG1	M					
PE057	ADMISSION INDICATOR	X	008	042	PEOPSEG1	M					
PE058	ADMISSION INDICATOR	X	008	043	PEOPSEG1	M					
PE059	ADMISSION INDICATOR	X	008	044	PEOPSEG1	M					
PE060	ADMISSION INDICATOR	X	008	045	PEOPSEG1	M					
PE061	ADMISSION INDICATOR	X	008	046	PEOPSEG1	M					
PE062	ADMISSION INDICATOR	X	008	047	PEOPSEG1	M					
PE063	ADMISSION INDICATOR	X	008	048	PEOPSEG1	M					
PE064	ADMISSION INDICATOR	X	008	049	PEOPSEG1	M					
PE065	ADMISSION INDICATOR	X	008	050	PEOPSEG1	M					
PE066	ADMISSION INDICATOR	X	008	051	PEOPSEG1	M					
PE067	ADMISSION INDICATOR	X	008	052	PEOPSEG1	M					
PE068	ADMISSION INDICATOR	X	008	053	PEOPSEG1	M					
PE069	ADMISSION INDICATOR	X	008	054	PEOPSEG1	M					
PE070	ADMISSION INDICATOR	X	008	055	PEOPSEG1	M					
PE071	ADMISSION INDICATOR	X	008	056	PEOPSEG1	M					
PE072	ADMISSION INDICATOR	X	008	057	PEOPSEG1	M					
PE073	ADMISSION INDICATOR	X	008	058	PEOPSEG1	M					
PE074	ADMISSION INDICATOR	X	008	059	PEOPSEG1	M					
PE075	ADMISSION INDICATOR	X	008	060	PEOPSEG1	M					
PE076	ADMISSION INDICATOR	X	008	061	PEOPSEG1	M					
PE077	ADMISSION INDICATOR	X	008	062	PEOPSEG1	M					
PE078	ADMISSION INDICATOR	X	008	063	PEOPSEG1	M					
PE079	ADMISSION INDICATOR	X	008	064	PEOPSEG1	M					
PE080	ADMISSION INDICATOR	X	008	065	PEOPSEG1	M					
PE081	ADMISSION INDICATOR	X	008	066	PEOPSEG1	M					
PE082	ADMISSION INDICATOR	X	008	067	PEOPSEG1	M					
PE083	ADMISSION INDICATOR	X	008	068	PEOPSEG1	M					
PE084	ADMISSION INDICATOR	X	008	069	PEOPSEG1	M					
PE085	ADMISSION INDICATOR	X	008	070	PEOPSEG1	M					
PE086	ADMISSION INDICATOR	X	008	071	PEOPSEG1	M					
PE087	ADMISSION INDICATOR	X	008	072	PEOPSEG1	M					
PE088	ADMISSION INDICATOR	X	008	073	PEOPSEG1	M					
PE089	ADMISSION INDICATOR	X	008	074	PEOPSEG1	M					
PE090	ADMISSION INDICATOR	X	008	075	PEOPSEG1	M					
PE091	ADMISSION INDICATOR	X	008	076	PEOPSEG1	M					
PE092	ADMISSION INDICATOR	X	008	077	PEOPSEG1	M					
PE093	ADMISSION INDICATOR	X	008	078	PEOPSEG1	M					
PE094	ADMISSION INDICATOR	X	008	079	PEOPSEG1	M					
PE095	ADMISSION INDICATOR	X	008	080	PEOPSEG1	M					
PE096	ADMISSION INDICATOR	X	008	081	PEOPSEG1	M					
PE097	ADMISSION INDICATOR	X	008	082	PEOPSEG1	M					
PE098	ADMISSION INDICATOR	X	008	083	PEOPSEG1	M					
PE099	ADMISSION INDICATOR	X	008	084	PEOPSEG1	M					
PE100	ADMISSION INDICATOR	X	008	085	PEOPSEG1	M					

Page from DePaul Data Element Dictionary

Figure 2

quired to reflect changing conditions. A sample print-out from a small portion of the DePaul DICT file is shown in Figure 2. Note that each line is a single record that contains the attributes of a single data element. Each element is uniquely identified by a standard 5-digit code, like PE008.

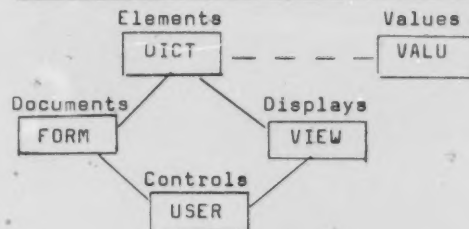
Conceptual View of Control Data Sets

Almost any data processing operation can benefit from the notion of creating simplified standard job streams, like an ACS, and basic CDS that are used by these programs. As seen in Figure 3, only 4 or 5 logical data sets are required:

1. DICT = Data Element Dictionary - all the system needs to know about an element, leaving extra space for new ideas later. Has unique element ID.
2. FORM = Documents that can enter ACS - array of elements under a common form ID. Can also be TP screen formats for input/output display & updating.
3. VIEW = Displays of element values extracted by system. Unique display ID which may equate to report #, parameter set #, etc.
4. USER = Users, files, data base controls & descriptions pertinent to environment in which the system resides.

A fifth data set VALU can be an extension of the DICT data set and contain the data values for an element for purposes of input editing or output translation from a code to expanded description. There can be cases where tables in VALU are so large that sequential search is impractical. Random organization in a separate data set is then

indicated. A good example would be a data element for the student's high school code. Whenever the high school code entered the system on a transaction (document) or left the system on printed or displayed output, the high school VALU would be accessed randomly by keying on the code to either edit input or translate output.



Control Data Sets - Logical view
Figure 3

It is significant that no formal data base is really needed to support the suggested Control Data Sets. Effective ACS systems have been constructed using ISAM, VSAM, BDAM or other non-data base access methods and file organization. The ACS functions of data collection, editing, updating, retrieval and reporting must still be programmed to work with CDS in the environment chosen. Whenever a shop develops its own ACS, it typically takes about one man-year - often, it only takes a couple of eager beavers around 6 months to come up with the basic system.

Use of ACS and CDS can have many benefits

- * Mistakes are easier to correct
- * Time schedules are easier to meet
- * Staff is far more productive
- * Existing systems can easily interface with GRS record stream

Future software is bound to follow these principles. To create such ACS and CDS can be a most valuable investment.

INFORMATION SYSTEMS & APPLICATIONS

Elementary / Secondary

A COMMON CORE OF DATA DESIGN
TO MEET STATEWIDE INFORMATIONAL NEEDS

Don Roberson C. Ray Thomas
CCD Project Director CCD Systems Analyst

An overview of the procedures to be conducted in the design of a statewide reporting system to meet the informational needs of all levels (district, state, and federal) of the Texas educational organization and the strategies selected for the implementation of the system.

PURPOSE

In November 1971, the State Board of Education adopted the State Plan for Computer Services which provided for the establishment and implementation of a statewide network system of computer services (on a cooperative basis) responsive to the requirements of the school districts, the regional centers, and the State. The major objectives of instituting cooperative services on a regional basis were:

- o To provide services in an economical manner;
- o To reduce the proliferation of equipment and redundant services;
- o To make services available to all school districts; and,
- o To provide a means of collecting data on a statewide basis in a usable format.

The network system was to provide uniform computerized files of educational data on all school districts for use in the school districts' daily operations (payroll, personnel, etc.) and State/Federal reporting. Comparability of input data was a primary factor in the presupposed development of the network system. Only if the input data were timely and accurate could the output data permit valid data processing applications which would be consistent over time. Therefore, the requirement was the identification of a standardized common core of data that could be collected from all school districts.

PROJECT DESCRIPTION

In October 1976, a project was organized to address the concept of a "standardized common core of data." The Project Team was charged with the responsibility to complete the following process objectives:

- o To conduct a comprehensive inventory of all source level data elements of school district report information (including student, staff, curriculum, finance, etc.) which are required by the Texas Education Agency;
- o To analyze potential methods of collecting source level data;
- o To develop "common core of data" concepts and conduct a feasibility study; and,
- o To develop an appropriate implementation plan for the Common Core of Data.

The Project Team (Director, Systems Analyst, and Research Assistant) works under the direction of a Steering Committee. The Steering Committee is comprised of personnel from the Texas Education Agency, and representatives from three of eight regional service centers which have data processing capabilities. The committee members function in a review, coordination, and advisory capacity to the Project Team. All products and recommendations of the Common Core of Data Project are submitted to the State Commissioner through appropriate channels for approval.

CONTEXT SCANNING

To determine the necessary source level data elements of required school district report information, the Project Team focused their inventory efforts on the existing State/Federal reporting system - TEA Bulletin #742 (Data Submission to the Texas Education Agency). The purpose of Bulletin #742 is to provide for the control of reporting data to and from the Texas Education Agency to ensure data will be used efficiently and effectively.

Bulletin #742 was reviewed by the Project Team to determine what source level data elements would be required in a "Common Core of Data" file system which would be utilized to meet State/Federal reporting. A source level element was defined as each element of information within a detailed record within each school district. Detailed records would be maintained on each district, campus, building staff, student, etc., and elements within, for example, the staff record would be: social security number, birthdate, etc. These elements are examples of source level data elements.

The Project Team reviewed a total of 389 reports contained in Bulletin #742. The project was concerned with reports required of school districts and the Project Team identified 143 reports which met this criteria. These reports were coded and resulted in the identification of 526 source level elements and 40 categories (i.e., district, campus, staff, student, etc.).

A computer system was designed to provide documentation for the Project Team's inventory activities. The documentation included:

- o List of data categories
- o List of source level elements with basic definitions and characteristics
- o List of Bulletin #742 reports
- o List of reports applicable to CCD with elements required for each
- o List of source level elements and reports that utilize each element
- o List of source level elements by due date

The Project Team clearly defined the technical problem as stated below.

"The current State and Federal Education Reporting System represents a substantial burden for the local school district in terms of:

- o The data collection process
- o The processing requirements of the State
- o The validity and timeliness of data
- o The cumbersome process of assimilating and disseminating data to the state agency divisions and the federal government."

The analysis of data report needs was an exercise in context scanning which provided the Project Team with an awareness of and entry into:

- o Requirements of State/Federal Reporting
- o Environment of the Organization
- o Verification of the Technical Problem

ALTERNATIVE SOLUTIONS

The next phase of the project design is to develop alternative solutions to the total problem. The specifications of the alternative solutions available to solve the problem is based on the following components of an automated information system:

- o Input Requirements
 - forms
 - procedures
 - data collection
- o Processing Requirements
 - hardware
 - software
- o Output Requirements
 - reports
 - forms
 - procedures

EVALUATION OF ALTERNATIVES

Each of the alternative solutions developed in the previous design phase is evaluated in regard to meeting the criteria established as desirable or required for the statewide source level data collection concept. The criteria to be utilized in this evaluation is as follows:

- o Timely and accurate state data
- o Standardized data definitions
- o State and federal reporting as a natural by-product of school district daily operations

- o Data meets information needs at local, state, and federal levels.

These criteria are to be prioritized in terms of economical, technical, and political impact. The correlation of the prioritized criteria to the alternatives provides the optimum alternative choice. This evaluation process is the third phase in the design process.

IMPLEMENTATION PLAN

The development of the total implementation plan (input, processing, and output) is the next phase in the design process. The first decision to be made is which type of implementation strategy is most appropriate for the situation. The two types of implementation strategies are:

- o Horizontal - This strategy installs one data processing application or process in all school districts at the same time. This process provides immediate involvement of all school districts in the state and removes the syndrome "it is OK for them but it will never work for me." This strategy would take longer for the state to obtain results from the CCD Project.
- o Vertical - A more practical approach is to implement the complete problem solution in one school district. This approach has a vertical impact because the data collected can be utilized by the local, state, and federal organizations for all applications. This strategy rapidly provides results which allow for evaluation of the system and keeps the project on a small-enough scale that modifications to the system can be made in the early implementation stages without major impact on the entire state. Also, it provides a mechanism for training technical personnel for implementing the system in the remainder of the state.

The objective in this phase design is to choose a conceptual approach to implementation primarily in accordance with the "political" needs of the situation. Once the decision on implementation strategies is made, the focus of the CCD Project is narrowed for the Project Team. In other words, the next phase of the project design concentrates on one of the following:

- o Horizontal Strategy - one data processing application for all school districts; or

- o Vertical Strategy - all data processing applications for one school district.

Also, this phase defines a precise schedule for the total implementation plan.

DETAIL DESIGN

This phase the project design is the point at which manpower resource requirements begin to increase as the demand for more specific detail knowledge in specialized areas of information systems (input, processing, and output) is being required by the nature of the work.

The fundamental steps (with no implied order of importance) within this phase are:

- o Definition of specific data processing applications/system output; i.e., state reporting, district payroll, district finance, etc;
- o Definition of data elements required to satisfy the needs of each of the data processing applications;
- o Development of detailed system and program specifications; and,
- o Development of software manual procedures, and forms to support the system.

This detail design is an implementation plan for the initial installation and pilot-testing of the system.

SUMMARY REMARKS

The Project Team has recognized two primary considerations relative to the implementation of the CCD Project. These considerations are:

- o Source level data collection implies that standardized operating procedures (i.e., payroll, personnel, finance, student daily attendance, etc.) must exist in all 1100 + school districts in Texas.
- o Prior to implementation of the Common Core of Data System, two problems must be solved - one "political" and one "technical." Thus far, decision-makers have been reluctant to act on either problem while using the other problem as an excuse.

A FINANCIAL DATA RETRIEVAL SYSTEM

Robert F. Wegener
Denver Public Schools

Users may specify the content of a report line, how records are to be sequenced, the number of totals, and whether the report should be in detail or summarized. They may also request that only a specific group of accounts be reported.

A line in a report is an arrangement of fields; its other dimension is sequence. Through use of a field table, a sequence index table, an account key file and a titles file, reports may be constructed. An additional dimension of the field table permits total levels to be varied, or data to be summarized. Parameters for record selection permit reporting of only a selected group of accounts.

A great bulk of written records, even from the earliest times, are concerned with financial matters. Augustus prepared a formal budget for the Roman Empire. Textbooks on double entry book-keeping appeared in the fifteenth century. The selection, classification and arrangement of financial data to point out the significant has a long history. When I was young, this seemed very depressing.

This long tradition contributes a great deal to the ease with which we can deal with accounting data, as compared to other materials with which we are sometimes required to work.

I like to think that the concepts we apply to financial data retrieval are applicable to other areas of concern, but I have had no opportunity to apply them except to records with a direct tie to accounting.

The system was not developed from a grand design. The first version was built to solve a practical problem presented by our Budget Office.

The Budget Office needs a series of reports at each step in the process of financial planning for the year ahead. In 1970 we expanded our account code structure to accommodate the needs of program budgeting in certain areas. The budget for some programs is controlled at the school level. Others, although conducted in specific schools, are controlled centrally. From time to time, significant changes occur in the distribution of administrative responsibility.

Using a separate program for each sequence needed at each step of the budget building process would have meant two dozen programs. Modifications were certain to be frequent, and the programs would need to be consistent with one another in many respects.

It seemed better to make one rather complex program designed to be accessible for modification and, better still, flexible enough to meet a variety of demands without modification. We accomplished this fairly well, and then the Colorado State Board of Education published a new accounting manual based on the new Federal Handbook II, with instructions that it be used for the 1977 budget. We had neither time nor serious inclination to adopt a new account code, and to train people in its use. Instead, we used and expanded the concepts developed for the budget buildup system, to provide appropriate cross references, and a generalized reporting system.

By treating separately the functions of record selection, sequencing, line composition, and providing totals, but interlocking them, we have made a flexible financial data retrieval system to deal with records containing an account reference. Most of our relevant files are accessible to the system so that we can prepare a variety of reports tailored to the needs and wishes of administrators throughout the school district. These range from a six-line summary for one department head, to a highly detailed presentation which another finds comforting and useful. From the first of October

until the end of the year, we supplied daily budget status reports to assist in financial management. Special one-time needs can often, but not always, be met by a brief review of user needs and of system capabilities.

For my purposes, a report consists of lines of quantitative data arranged in columns. Identifying data may accompany the quantitative data in a line. A report is made by

1. Selecting records.
2. Defining the composition of groups and subgroups, and arranging records in the sequence thus defined.
3. Composing a line using data derived from a record, and composing a line using data from a group of records.

The process by which the system operates is initiated through a Report Request (Exhibit I).

The report group and number defines the composition of a line of print from an individual record, and the composition of a total line. It may also define the composition of a "special total" line. That is all it does. Everything else is in a group of interlocking routines which provide the data as needed.

The next section of the Report Request allows specification of the files to be used to provide data. This permits the requester to use only the files relevant to a particular report. This section could be more compact since some files are not relevant to some report groups; however, we spread it out to avoid the confusion possible if column five were to mean one thing to group AR and another to group BR. Of course, we now have the problem that there is no space for specification of additional files.

The next segment defines the sequence desired. If the number entered here is less than 100, the entire report is to use the same basic sequence. If 100 or greater, we get a complex sequence in which different parts of a single report may be sorted differently. At present, we have provided thirty basic sequences, and four complex ones. One of the complex sequences actually uses thirteen of the basic sequences in preparing a report.

The next columns allow specification of the number of total levels to be provided. This can be anything from one to twelve. If it is left blank, a standard total level for the sequence used will be provided.

If the next columns "summary" are left

blank, the report will be prepared in detail. If an entry is made, the report will be summarized at the level specified, again from one to twelve. Thus we can, for example, summarize at level 11, and place our minor total at level 6.

Page break specifies at what total level a jump to next page should occur. If blank, the standard page break for the sequence used will be applied. The next three segments have to do with record selection. Another kind of selection is based on "Record Type" at the end of the record.

"Selection Type" signifies that records are to be selected by matching what is shown in the selection keys, or by identifying records in the range between the two keys. Records which match or are in range may be selected for or excluded from the report to be prepared.

"Selection Segment" identifies the content of the selection key as being (1) our local account number, (2) the related account from the new Handbook II, or (3) our organizational key. Matching can be used to select one account, or all records with the same major object, or all records for a cost center.

Although most routinely prepared reports use all the records in the specified files, the ability to select data for special purposes is increasingly important to us in meeting the needs of our school district. Often it would be useful to select simultaneously on elements of the organization key, and on elements of the account number, but this we do not now have.

"Record Type" provides selection on a different basis. For example, records for accounts now obsolete are normally excluded from reporting, but in some circumstances their data is needed.

"Number of Copies" generates a console message for the computer operator to mount appropriate paper in the printer.

"Date" is translated and used in the report heading.

When the Report Request is read, the files required are read through in turn. For each record the Account key file is read. This file contains our local account number, the Handbook II cross reference, and an organization key. If there is any record selection, it is applied at this point. If the record is to be used, a sort key is built from the account key data by reference to the sequence table, and the record is delivered to sort. Subsequently, the specific report program, and the routines for titles and totals take over.

Since reports required are frequently to be used by people to whom the significance of the account code structure is not necessarily clear, and since, in arrangements controlled by the new Handbook II accounts, our own account numbers do not fall together in an obvious sequence, we provide titles for all groups and subgroups. This is accomplished by use of a file containing all the necessary titles. The bulk of the file consists simply of names for the elements of the account codes, both our own and those of Handbook II. But this is not enough. "Organization" in our account code might be a cost center, a sub-center, or the location benefitting from expenditures made by another cost center (building maintenance is the most obvious example). The significance of certain administrative function codes differs in different cost centers.

Where this kind of ambiguity does not exist, function codes tend to be grouped by ranges of numbers, so that digital position cannot be used directly. In the program area, some groupings are significant, but others are a unique identification of an activity. The account code contains no direct key to its place in the administrative hierarchy.

Given the rationale by which a specific account is constructed, these problems can be resolved. A routine to do this was central to the budget buildup system. To it we have added elements necessary to assign the new Handbook account. Most of the latter is accomplished by reference to tables which can be maintained by personnel of the Budget Office, but in some circumstances a more complex analysis is required. This is included in the account key maintenance routine. This routine is the most difficult part of the system to maintain, because changes in administrative structure, and in the interpretation of elements of account code do occur. When a new account is opened, it is constructed according to a set of rules, but when rules are interpreted in a specific situation, the result may differ from the interpretation embodied in the computer routine. Strange things may occur. We are all getting better at this, so that the computer routine has become fairly stable. Whenever a new account is added, or a change made, this routine is used. Its output is the Account-Key file which is used in assembling records for any report. Its elements are the Handbook II account, Fund, Function, Object, Program, our organizational key, Division, Subdivision, Cost Center and a key for Division, Subdivision and Cost Center, which benefits from an expenditure. A comparable structure exists for receipt accounts. The elements of the Account Key file are all described in the Titles file.

The Account Key looks like this:

Our number: 00 211 252 3310 655. The elements define: general fund, an elementary school, classroom teaching, a supply object, and a program in special education. This translates to: 10 1220 4301 0000 for the Colorado manual. The elements define: general fund, instruction for mentally retarded, library books. The last four digits are for subprogram, and are not now used. The other element of the key for this account defines its organizational position: 3 6 2 171 3 1 2 211. The first four elements define: Division of education, pupil services, elementary level, department of special education. The following elements refer to the specific school for which these expenditures are made.

When a data record is read, its account number is used to read the Account Key file. From the Account Key data, and our local account, a sort key is constructed to place the record in sequence for reporting. The sort key is constructed according to data derived from the sequence table. The sequence table contains specifications for thirty "basic" sequences. "Complex" sequences, in which more than one basic sequence is used in a report, require analysis of Account Key data to determine which basic sequence will apply to the record. The specifications for a basic sequence consist of the primary keys or elements in the Titles file. These, being unique, can be interpreted to indicate portions of the Account Key. For example, the table entry for sequence 2 is interpreted as follows:

Sequence 02	
01	(Account Type)
15	(Handbook II Fund)
16	(Handbook II, Major Function)
04	(Division)

Etc. up to fourteen elements.

The sequence table is external to the program, so that additions or modifications do not require programmer intervention. Complex sequence specifications are internal, however. Their modification is a more difficult procedure.

The record delivered to sort is a standard record. It consists of a primary sort key of fourteen elements, each of three characters. This is followed by a secondary sort key of thirty characters. It contains detailed record identity. Its composition is dictated by the group to which a requested report belongs. This is followed, in the body of the record, by data occasionally necessary to translate a three-character element of the primary

key into a four-character reference to the Titles file. (Without this, the elements of the primary key would need four characters each, which seemed wasteful.) All of this is followed by the record itself and whatever filler is necessary to bring the total length to 240 characters.

The after sort procedure for quantitative data from each file is also standardized. This reduces the unique requirements for a report. It also provides a straightforward approach to the data files, so that making a new file accessible to the system is not too onerous.

The after sort procedure updates a Totals Table (Exhibit II). This contains 1,125 fields, arranged in a 15 x 75 matrix. Each field contains eleven signed, packed, digits.

The shorter dimension of the table provides for:

- a. Twelve normal total levels.
- b. "Special Totals," that is, totals which fall outside the hierarchy indicated by the sorting sequence.
- c. Accumulated detail. It is to this column that all data is added as records are processed.
- d. A column to permit manipulation of data for printing.

The longer dimension of the table provides niches for the quantitative data from whatever records are used as input. Since it is highly improbable that certain files will ever be used together in a report, there is some overlap in use of these niches by various files. That is, no one is likely to ask for next year's budget request together with unfilled requisitions on the warehouse.

Standard detail processing consists merely in adding the quantitative data fields to an assigned niche in the Accumulated Detail column of the Totals Table. Some files have separate fields for each kind of data they contain; most transaction files contain only one quantitative field which finds its niche according to the transaction code in the record.

Up to this point, processing is common to all records. The only variation is in selecting the niches to which quantitative data is added.

If the report being prepared is not summarized, the record is here made available for the specific report program to compose a line of print, and, if appropriate, to call for a "Special Total."

All totals are taken by subtraction in the

Totals Table. Since quantitative data is added to niches in Accumulated detail, this column of the table contains values accumulated from all records processed. Nothing is added to other columns of the Totals Table. When a total is needed, the values of the appropriate level column are subtracted from those in Accumulated Detail, with the difference going to the Total for Print column. The Accumulated Detail values are then moved to the total level column, to provide a base for the next total calculation at that level. The specific report program then operates on the data in Total for Print to compose a total line for the report.

When all totals called for have been printed, the Titles routine takes over. Using elements from the primary sort key of the next record, and elements from the sequence table, it reads the Titles file to supply titles for the following group of records. This, too, is a standard routine within the system, and operates independently of any requested report format.

"Special Totals" are a characteristic of certain reports. The need for them may occur when multiple files, including transaction or staffing files are used. Totals may then be wanted for these files for each account number, although the general total level requested is at some higher level. Processing in the Totals Table is the same as for any other total, but the requirement must be spelled out in the report specification, since these totals are to be presented regardless of how the general total level may be varied. Comparatively few of our reports have such a requirement, but as an aesthetic matter, if nothing else, it would be desirable to incorporate the required processing completely in the "Totals" routine and allow their use to be specified on the Report Request.

As I said earlier, this system was first developed to meet an immediate problem. It still contains some marks of its heritage. If we were to do it over, we would no doubt revise the procedures for Special Totals. We would broaden the basis on which record selection operates to allow organizational references and segments of the account number to be used simultaneously. We would probably generate the Account Key as records are processed, instead of maintaining the key in a separate file.

By and large, however, the system as it stands is a very useful tool in our school district.

AN EDUCATIONAL MANAGEMENT INFORMATION SYSTEM:
DATA COLLECTION PROCEDURES

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A systematic approach to planning and presenting the data requirements of a State Department of Education's divisions, programs, and/or projects is desirable because too often data collection is random and haphazard. The purpose of this paper is to introduce the user of educational information to the principles of Management Information Systems, and to provide the user with a generic educational data collection model.

The procedures expounded in this manuscript are generic in nature and have applicability at the federal, state, or local educational level. In fact, regardless of whether the user of this model is in the educational, business, or governmental domain, it has just as much applicability.

A State Department of Education Management Information System (MIS) is defined as the integrated collection, processing, and dissemination of all internal (within the State Department of Education) and external (Local School District) data that flows throughout the educational system on an accurate and timely basis.

In the New Jersey State Department of Education, the Office of Management Information (OMI) is the principal agency responsible for planning and coordinating the development and implementation of such a Management Information System. To carry out this assigned function, the Office of Management Information has three purposes to achieve and maintain. These purposes are:

To deliver continuous information on past, present, and future educational/administrative performance which, once reviewed by decision makers, will enable them to take appropriate action;

to minimize the flow of redundancies and unjustified data collected at both the State and the Local School System levels; and

to assure the accuracy and timeliness of data disseminated throughout the Department of Education.

A strong communication and logistical network must be developed by the management information system to coordinate

the establishment and continuation of the system. This communication network (Information Communication System) will provide Program Managers at both the state and local level with an understanding of why certain types of data are needed by particular divisions in the State Department of Education. It also enables individual data needs to be extracted from existing data in his/her Division or another Division. To facilitate the smooth operation of this communication network, each of the State Department of Education's Divisions and County Offices has assigned personnel to work with and assist the staff of the Office of Management Information. These staff members are called Data Analysts. They are the:

DIVISION DATA ANALYST, and
COUNTY DATA ANALYST.

Data Analysts, in conjunction with Office of Management Information personnel, constitute the Department's Management Information Team.

The procedures expounded in the document should serve as a Standard Operating Procedure (SOP) to be followed by Department of Education personnel involved in the collection of data from local school systems.

Management Information System Team

A Management Information System is a long-range operation that involves continuous development and expansion. Only through the combined efforts of the staffs of the

Office of Management Information, the Divisions, the County Offices and the regional Educational Improvement Centers will data collection from local districts be successful. The Management Information System Team can best be described by the following relationship:

OMI + CDA = MIS TEAM, where
OMI = the Office of Management Information,
CDA = the County Data Analyst,
DDA = the Division Data Analyst, and

MIS TEAM = an integrated communicative effort to coordinate data needs and requirements of the entire Department of Education.

Briefly, the duties of the members of the Management Information System Team are twofold. In summary, these duties are:

First, County Data Analysts (through program cost centers) are responsible for collecting and editing data promptly and then transmitting accurate data to the Office of Management Information or the appropriate program cost center. Both the County Data Analyst and the Division Data Analyst are responsible for monitoring and clearing through the appropriate channels the collection of data by program cost centers, and for insuring that standard data collection procedures as described below, are maintained.

Second, County and Division Data Analysts and staff of the Office of Management Information are responsible for facilitating the collection, consolidation, and synthesization of Local School System data collection instruments. All instruments will be reviewed by Data Analysts. Such a process should minimize redundancies and unjustifiable data collections within Programs, Divisions, and County Offices. The Data Analysts, under the direction of the Office of Management Information, periodically will repeat this process as a Department-wide review.

The result of the Management Information System Team approach is an information system that can provide for one-time only collection of data, easy retrieval of stored data, and ready access to existing data.¹

Policies for Data Collection

Management Information System Team members must rely upon the policies established by the Commissioner of Education when collecting data from Local School Systems and their communities. Therefore, when

using this document the reader should continually review as a point of reference the following policy statements:

POLICY STATEMENT #1 No instruments shall be authorized and used to collect data from Local School Systems unless they follow the Standard Operating Procedures of the New Jersey State Department of Education for collecting data from local school systems and are routed through the Office of Management Information.

POLICY STATEMENT #2 No Program Cost Center within the New Jersey State Department of Education will collect data directly from Local School Systems unless they coordinate their needs with the Office of Management Information.

POLICY STATEMENT #3 No federal agency or its contractors shall collect data directly from Local School Systems. All such requests for data must be routed through the Office of Management Information and then assigned to an appropriate program cost center.

POLICY STATEMENT #4 No Local School System will be required to complete a data collection instrument that has not been reviewed and approved.

DATA COLLECTION PROCEDURES

Data collection is an orderly procedure for acquiring information from a particular population. This section introduces the reader to three data collection publications. It then describes a step-by-step procedure for gathering needed information related to Local Education Systems (LEA Data Collection Model).

Data Collection Publications

Before reviewing the procedures to collect data from Local Education Agencies, it is essential to have a knowledge of three publications normally associated with large scale educational data collections. These publications--a Data Element Dictionary, an Annual Data Collection Plan, and an Annual Publication Abstract Plan--inform Local Education Systems, County Offices, various educational associations, and others of: (1) what the Department plans to collect, (2) who within the Department is responsible for collecting data, (3) when the Department intends to collect the data, and (4) how the Department plans to use the data.

Data Element Dictionary. A Data Element Dictionary is based upon the principles of the National Center for Educational Statistics (NCES) handbook series that classifies and standardizes educational terminologies.² It provides a commonly-accepted vocabulary which is necessary for an integration of data bases across organizational lines.

The Data Element Dictionary defines the characteristics of data elements used and available in the New Jersey Department of Education. The Dictionary is used to build a common data base and provide "detailed descriptions of each item of relevant data to permit retrieval..."³ by Program Managers. When a data collection has been approved, the Data Element Dictionary will be updated to include new elements or modified to reflect changes in data element definitions.

Annual Data Collection Plan. The Annual Data Collection Plan is a publication of the approved instruments planned for implementation during a given school year.⁴ It lists by month the justification for and the types of instruments that will collect data. Through the Annual Data Collection Plan, Local School Systems, County Offices, and Program Managers will be notified in advance about forecasted collections. The plan shall be updated during the year by addendum notices (insert sheets) distributed by the Office of Management Information.

Annual Publication Abstract Plan. The Annual Publication Abstract Plan is a publication that describes in abstract form the results of planned data collection of the forthcoming year. For example, if an instrument collects student enrollments by grade and school, what products or publications will result from this data collection and when will its documentation become available? Some data collections might not require a publication; in this case, the data collection itself might be the product. For purposes of the Annual Publication Abstract Plan, a publication may be defined as any planned printed or xeroxed memorandum, article, outline, handbook, guide, standard operating procedure, report, or study that is compiled, edited, and published by a program cost center.

Local Education Agency Data Collection Model

A plethora of instruments that have never been reviewed through a common data base are described in Management Information System vernacular as being fragmented or non-integrated. To cope with this phenomenon, integrated systems require

structured or orderly data collection procedures which will identify who or what program within an organization collect data. After this identification is known, certain steps can be taken to review all instruments (old and new) for non-fragmentation. Once an instrument is reviewed and approved, it can then be placed in an Annual Data Collection Plan. This item analysis of all data elements on a given instrument allows one to see if a data element is being collected elsewhere. The Data Element Dictionary should aid this process because it identifies who is collecting individual data elements. If data elements are being collected elsewhere, the instruments effected must be synthesized before incorporation into the Annual Data Collection Plan.

The Data Collection Model. The New Jersey Department of Education's procedures for collecting data from Local School Systems are displayed in a series of twelve steps that detail the Local Education Agency Data Collection model. These twelve steps consist of two primary data collection functions: (1) the analysis and synthesis of requests to collect data, and (2) an implementation plan for collecting the data from Local Education Agencies.

The analysis and synthesis function pertains not only to new instruments but also instruments that have existed over the years. This function requires, as an initial step, the review by Division Data Analysts of all the instruments in their Division's programs; that is, an analysis of each instrument and then a synthesis of all the instruments within the Division. Any data elements that are identical should be recognized and stopped from being collected by more than one program. After Division instruments have been synthesized, the steps of analysis and synthesis can occur on a Departmental basis.

The second function, implementing a plan to collect data, involves assigning this function indirectly to a program or a County Data Analyst (see Policy Statement #2).

Operational Functions of the Management Information System Team. The following twelve steps of the LEA Data Collection Model are in essence the functions of the Management Information System Team and data requestors. These steps are:

Step 1.
Requests to collect data enter the system. There are two possible entry points: requests from Program Managers, and requests from other agencies (Federal, State, Local, etc.).

First, if a Program Manager wants to

collect data, he or she must complete an MIS Review and Approval Request. The first part is the MIS Review and Approval Document, and the second part is the Publication Abstract Document. The MIS Review and Approval document provides information concerning the justification and key duties for the collection of data. An abstract of the report to be produced from the data collection must be provided on a Publication Abstract document. Copies of the actual instruments to be used in the data collection are attached to the above-mentioned documents. Program cost center requests to collect data are satisfied when both documents, including copies of the data collection instruments, are completed and forwarded to the next step. These documents, if approved, will be the inputs for the three publications discussed earlier (the Data Element Dictionary, the Annual Data Collection Plan, and the Annual Publication Abstract Plan).

Criteria for review and approval fall within two major categories: (1) Justification, and (2) Technical Analysis. "In special circumstances, instruments not based directly on law or regulation may be authorized...on an emergency basis when such data are critical to program operation and delay would seriously jeopardize program activities."⁵ The Division Data Analyst will use a criteria check sheet in his evaluation of the documents submitted. A document should not be forwarded to the next step unless all criteria are accomplished.

Requests from other agencies (Federal, State, Local, etc.) are submitted in the same manner as Program requests. However, in the case of Federal requests, the Chief State School Officer's Committee on Evaluation and Information Systems (CEIS) reviews, through an item analysis, Federal Program justifications for collecting each data element. Because of the close liaison with CEIS, the Office of Management Information must be informed and notified of all requests for data from the Federal Government, as stipulated in Policy Statement #3.

Step 2.

After a Program Manager completes the two MIS Review and Approval documents, he or she then submits the request to his/her Division's Data Analyst. The Division Data Analyst reviews the documents according to established criteria and forwards the documents, copies of the instruments, and the criteria check sheet to the Office of Management Information for review and approval. OR, the Data Analyst returns the documents to the Program Manager. In that case, the Program Manager will be asked for further clarification and/or insertion of needed

data. The Division Data Analyst will at that time provide the Program Manager with the criteria check sheet on which the Analyst has noted satisfactory and unsatisfactory criteria and a written explanation.

Step 3.

The Office of Management Information will make the final review and approval of the instruments to be used in the collection of data from Local School Systems. Based upon that evaluation, an instrument will be either disapproved, conditionally approved, or approved.

DISAPPROVED. If the documents and instruments submitted by the Program Manager are disapproved by the Office of Management Information, the Program Manager either may accept the decision or may request an appeal meeting with a MIS Board of Appeals. That appeal will be channeled through the Division Data Analyst to the Office of Management Information, which will arrange for an appeal board meeting.

The MIS Board of Appeals is composed of the Deputy Commissioner (chair), a representative from the Office of Management Information, and all Division Data Analysts. A decision by the Appeal Board should be reached within 10 days of the petition for appeal.

If an instrument is disapproved by the MIS Board of Appeals, the instrument is at a STOP and cannot be used for data collection. If, however, an instrument is approved by the MIS Board of Appeals, it continues through the process as though the Office of Management Information had originally approved the instrument for data collection.

CONDITIONALLY APPROVED. If an instrument submitted for a Program Manager is conditionally approved, the revisions or modifications suggested can either be accepted by the Program Manager or he/she can appeal the decision to the MIS Board of Appeals. In either situation, the instrument may be approved after an agreement is reached.

APPROVED. If an instrument submitted by the Program Manager is approved, five activities must occur. First, an MIS number and date of expiration will be assigned and the Data Element Dictionary will be updated by the Office of Management Information (Step 4). Second, the Division Data Analyst will be notified of the approval and he/she in turn will notify the Program Manager. Third, both the Annual Data Collection Plan (Step 5) and the Annual Publication Abstract Plan (Step 6) must be updated. Fourth, the Office of Management Information will assign the data collection function

indirectly to either the Program Manager or the County Data Analysts (see Policy Statement #2). Fifth, the Office of Management Information will provide a standard letter of authorization that must be attached to the actual data collection instrument. This last activity coupled with the Annual Data Collection Plan will insure the adherence of Policy Statement #4 and provide local school system personnel with an authorization check.

THE SAME PROCEDURES FOR REVIEW AND APPROVAL BY THE OFFICE OF MANAGEMENT INFORMATION APPLY TO INSTRUMENTS SEEKING APPROVAL BY OTHER AGENCIES (FEDERAL, STATE, LOCAL, ETC.). The only difference is that an MIS Review and Approval document will be completed by the Office of Management Information or the Program Manager assigned the responsibility to work with the agency requesting the data.

Step 4.

Once an instrument is approved, the Data Element Dictionary must be updated by the Office of Management Information to include new data elements and an identification of the new user of existent data elements. There will be an annual review of the dictionary to determine if data elements should be deleted or modified to show changes in the state of the art. The Data Element Dictionary shall be distributed to all Program Managers, Division Data Analysts, and County Data Analysts. This will allow all users to readily select data elements that have been defined and also will provide an identification of where a specific data element can be located in the Department.

The steps just described represent the function of analyzing and synthesizing requests to collect data. The other function to be covered within this section on Data Collection Procedures involves Steps 5 through 12, the IMPLEMENTATION OF A PLAN TO COLLECT DATA.

Step 5.

After an instrument has been approved, the local school system(s) in question should have advance knowledge of when they can expect to receive the instrument in question. That advance notice is one of the primary reasons for continually updating the Annual Data Collection Plan.

Prior to March 1 of each calendar year, all Program Managers are required to provide their Division Data Analyst with four copies of their programs' data collection requirements for the forthcoming year (beginning July 1 and ending June 30). Once received, Steps 1 through 4 will be reviewed again to insure consistency of data collection. The Program Manager shall be informed then of the results of the review by the Division

Data Analysts, and the Program Manager then may exercise the options described under Step 3.

Data collections (special reports) not included in the Annual Plan must be submitted to the Division Data Analyst at least 45 days prior to the planned date for distribution. The Office of Management Information will complete the review and approval within 10 working days from the date of request.

The Annual Data Collection Plan should be distributed to all publics prior to July 1 of each year. As stated earlier, updates to the Plan will occur throughout the year (updates will be kept to a minimum).

The preparation of the Data Collection Plan is the first stage for implementing data collection. In order to be included in the initial Plan, an instrument must be approved by May 1 prior to the school year in which it will be distributed. All approved state, federal, and other agency-scheduled data collections will be included in the plan. Local School Districts will not be required to respond to any requests for data not in the plan unless a special authorization and MIS Statement of Authorization is provided.

Step 6.

The Annual Publication Abstract Plan was discussed previously. Its dates for completion and distribution are identical to that of the Annual Data Collection Plan.

Step 7.

The Office of Management Information will review all proposed data collections and through a feasibility analysis assign the data gathering activity to either the County Data Analyst, the Program Manager, or both. If work loads permit, the County Data Analysts will be assigned to collect data for certain programs. Program Cost Centers themselves may be assigned to collect the data with or without the assistance of the County Data Analyst.

Steps 8-12.

The Division Data Analyst (Step 8) will assist in determining (1) the most expedient and efficient manner to conduct the data collection, and (2) whether the Program Cost Center Manager (Step 9) or the County Data Analyst (Step 11) should collect the data. If the Program Manager is not assigned the responsibility for data collection, he or she will aid the County Data Analyst in performing the data collection function. The final step (Step 10 or 12) in these procedures is to collect the data from the Local School Systems and then begin to process the data either manually or through a computer.

The above data collection procedures are the component parts of the LEA Data Collection Model. All programs in the New Jersey Department of Education and other agencies (Federal, State, Local, etc.) must adhere to these procedures. If they are not followed, the response burden of the public schools in New Jersey will remain inordinately high.

1 This purpose can only be achieved through the utilization of fourth generation computer technology. Anything less will necessitate duplication that is created by program levels needs. Examples of computer utilization include: John Dearden, "Systems Organization and Responsibility," and Neal J. Dean, "The Computer Comes to Age," in Managing Computer-Based Information Systems (Homewood, Illinois: Richard D. Irwin, Inc., 1971), pp. 591-622.

2 See NCES standard terminology handbook series on facilitating and improving the collection, maintenance, and reporting of educational information.

3 Through the use of a data dictionary, all facets of an organization's data can be effectively used. See John J. Cahill, "A Dictionary/Directory Method for Building a Common MIS Data Base," The Technology of Data Base Management Systems (Arlington, Virginia: College Reading, Inc., 1974), pp. 284-290.

4 Several State Departments of Education are employing the use of Annual Data Collection Plans. For example, see the Annual Data Collection Plans of Colorado, Florida, Minnesota, Iowa, and Texas.

5 Review and Authorization Procedure for Data Collection Instruments of the Wisconsin Department of Public Instruction.

AN HIERARCHICAL APPROACH TO STUDENT DATA BASE FOR SCHOOLS

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The experiences of several school districts have been combined with those of the author and merged to develop a prototype Student Data Base design. This paper presents the design, design trade-offs and the logical relationship of several applications to the physical data base. The features of an hierarchical data base structure are examined in relation to the data base design.

Conceptually, Data Base Management was an instant success. Lack of understanding, lack of experience, and early software limitations, however, have slowed the actual growth rate. It is only recently that the full potential of the data base concept is being realized.

The prime benefit of data base cannot be overstated. The concept provides the ability to add data elements and data structures without affecting existing programs. This is one of the major reasons why the frontier of application technology has been expanded. As new functions are added, new data elements and data structures are inevitable. This capability reduces the reprogramming effort necessary to add new functions so that programmer time can be used more productively.

Data bases reduce redundancy, thereby reducing data inconsistencies and providing the vehicle for complete integration of applications. No longer is there a requirement for a grade reporting and an attendance and a scheduling system. Instead, using the data base approach, a single system can evolve.

IBM's implementation of a data base management system is an hierarchical one, Data Language/I (DL/I).

DL/I separates the physical organization of the data from the application program. This is accomplished via a common symbolic program linkage and by data base descriptions external to the application program. It is therefore possible to make changes and additions to the data structure without affecting current

programs. Other features of DL/I are logical data structures, data independence and segment sensitivity.

To understand how data is defined in DL/I let's look at an example as shown in Figure 1.

Each block in this hierarchical structure represents a segment to DL/I. A segment is a data element of defined length, containing one or more logically related data fields. These segments become the basic data elements that interface between the application program and DL/I.

The segment at the top of the hierarchy is called the root. The segments below the root are referred to as dependent segments. A dependent segment cannot exist unless the segment immediately above it is present. All of the segments combined are called a data base record.

A root segment, in this case "Student ID," can occur only once per data base record.

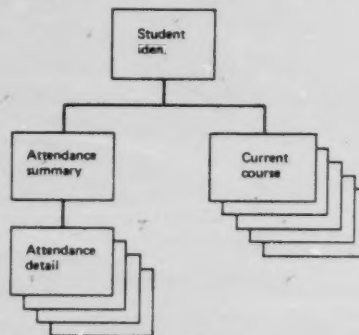


Figure 1 : An Hierarchical Data Base

A dependent segment can occur any number of times, or may not exist at all. Note that there are several occurrences of the "Attendance Detail" and "Current Course" segments.

The segment concept is important to the application programmer who sees a series of segments in a hierarchical relationship and requests segments of data, rather than records as they exist on a storage device.

The hierarchical structure and segmentation approach provides for data independence, segment sensitivity, data base flexibility, reduction of redundant files, simplified data management, logical relationships, and secondary indexing.

One of the key features of the hierarchical DBMS is the ability to relate data segments, either within the same data base, or between two separate physical data bases.

As can be seen by the arrows in Figure 2, a relationship has been defined between the current course segment in the student master data base and the section segment in the course master data base.

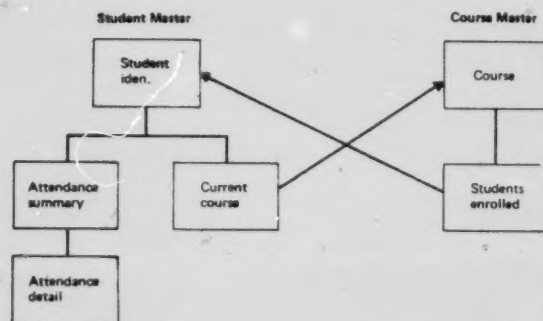


FIGURE 2 : Logical Relationships

The first step in designing hierarchical data bases is to identify the data groups to be described, such as: Student, Course, School, and Instructor. Then, the root segment and the dependent segments must be described.

The root segment contains information that is common to all segments within a data base and generally used by most processing programs accessing the data base. For example, if the entity is a person, a name would be common to all of the dependent segments and may reside

in the root segment. Within the root segment also would be data that would sequence the data base, such as student identification, district number, or school number.

Dependent segments are formed by taking into consideration:

- ° How the data fields relate to each other. Are they processed together? Are they modified together, or deleted together?

- ° Whether the data is sensitive. Is it confidential information that should be protected by being placed in a segment by itself?

- ° Whether the proposed segment will be duplicated. In other words, will the segment type occur a multiple number of times.

Dependent segments have two important characteristics; they are optional and they may be repeated as often as necessary.

While there are no strict rules in designing data bases, experience has shown that the following areas should be considered:

- Avoid duplication of data by moving it up in the hierarchy and/or using logical relationships.
- Separate optional data from required data.
- Carefully identify a sequence field for the data base.
- Avoid a wide range of segment sizes.
- Protect sensitive data.
- Keep initial design simple; i.e., 3-4 levels of hierarchy with 15-25 segment types.
- Organize segments so those of highest frequency of use are above and left of those with lower frequency.
- Establish secondary indices per the requirements of the processing against the data base.

Now let us discuss the data elements that could be utilized in a student data base record. In addition, the segments necessary to support several student applications will be covered. These data bases will allow the construction of several logical data bases.

This is intended to be a guideline for a typical secondary school system. Individual requirements would dictate whether all data elements or segments are necessary. Also, users may have additional data items that must be designed into the data base.

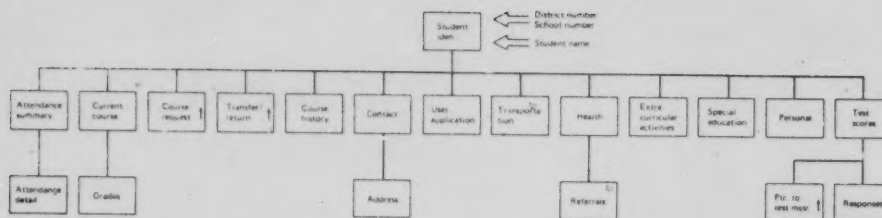


Figure 3 : A Typical Student Data Base

The student identification segment is the root segment of the Student Data Base record. It should also be logically a part of the Course Data Base, representing either a student enrolled in a class or a student requesting a course. These logical views can best be accomplished through the use of the DL/I logical relationship facility.

The key to the student identification segment should be a student identifier.

The student identification segment should contain the student's name, birth date, sex, and additional nonsensitive data relating to the student. Sensitive data should be placed in another segment, such as the personal segment, in order that a higher level of security might be enforced.

Several applications require accessing student data by student name. Therefore, in addition to the primary sequence of student identifier, the student identification segment should also be indexed by last name, first name, middle name, and birth date. This is probably best accomplished through the use of the DL/I secondary index facility.

It may also be desirable to create a secondary index on school district and school number. This would allow processing the data base in school sequence within district.

The attendance summary and attendance detail segments are used for attendance accounting.

The attendance summary segment is dependent to the student identification segment. The key to this segment is reporting period. Dependent to the attendance summary segment is the attendance detail segment. The key to the attendance detail segment is date. The segment would be created only when the student has an absence to be recorded. The attendance summary would also be updated to reflect all dependent segments. An occurrence of the attendance summary segment would exist for each reporting period.

The transfer/return segment is a means of tracking a student as he moves from school to school. The key to this segment is date of entry.

The current course segments represent all the courses in which a student is currently enrolled. This segment is also a pointer to the section segment of the Course Data Base.

The grades segment contains sensitive information and would not be available to all users. The key to the current course segment is course and section number, the key to the grade segment is date.

The course request segment is a unidirectional pointer to the root segment of the Course Data Base. One occurrence of this segment will exist for each course into which the student has requested enrollment. The key to this segment is course number.

A course history segment is created for every course in which the student has been enrolled. It is a copy of the current course segment with additional data elements showing exit reason and final grade. This segment does not point directly to the Course Data Base. However, the Course Data Base can be accessed using course number and, if required, section number, to obtain additional information such as course title.

The contact segment may be used to record data pertaining to relatives, personal references, emergency contacts, or other types of personal contacts necessary to the schools.

Dependent to the contact segment is the address segment. For each student and contact, multiple addresses can be maintained.

The user application segment is included to show how the individual installation can add to the Student Data Base. It does not imply that the segment must be located in this position in the hierarchy, but is put

here only to show the ease of handling individual requirements.

The transportation segment is a single occurrence segment for any student using school or public transportation enroute to school.

The health segment can be used as an indicator to files kept outside the system, in addition to an online record of the students immunizations. Dependent to the health segment is the referrals segment. The purpose of this segment is to track any action that the student was advised to take for reasons of health.

The extra-curricular segment is used to indicate current and/or past extra curricular activities.

The special education segment is used to track special education programs in which the student is involved.

The personal segment is a single occurrence segment logically related to data within student identification segment. However, it is separated in order that it might be given a higher level of security. Data in this segment should not be made available to programs except on a "need to know" basis.

The test scores segment is a variable length segment and contains the actual results (scores) the student received.

The test pointer segment is a unidirectional pointer to the Test Data Base, which contains a mask for the test responses. The test responses segment contains the actual responses the student recorded when taking the test.

Figure 4 is the hierarchical view of the segments in the course data base.

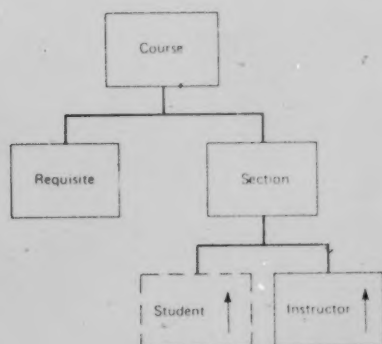


Figure 4 : A Typical Course Data Base

The course segment is the root of the Course Data Base record. This record serves to identify potential and current course offerings as defined by the school system. The key to the course segment is course number.

The requisite segment will occur as many times as required to define all the prerequisite and corequisite courses for the course identified in the root segment. If no requisite courses exist for a given course, this segment will not be present.

The section segment, is used to further define an individual course offering. The use of this segment allows a course to be defined one time for a school system and still allow each school to specify its start dates, credits, etc. The key for this segment is school and section numbers.

The student pointer segment has as a key the student identification number. This segment is created when a student is enrolled in a course. The presence of this logical relationship allows the application programmer the ability to access directly all students enrolled in any section of a course. From the Student Data Base side, it allows the accessing of all courses enrolled in by any student.

The instructor pointer segment can be a multiple occurring segment that identifies the instructors assigned to a given section. This segment is also a pointer to the root segment of the Instructor Data Base.

The School Data Base does contain two pointers, one each to the Course and Instructor Data Base. Figure 5 shows the hierarchical structure of the segments defined for the School Data Base.

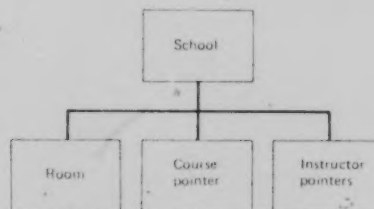


Figure 5 : A Typical School Data Base

The school segment is the root of the School Data Base. Each record in this data base describes one school within the school system and contains information describing the location and operating periods of the school.

The room segment is used to describe each room within the school. The utilization codes provide a means of classifying the room resources according to specific physical attributes. Some examples are general room size, type of room, and special equipment available.

A course pointer is used to describe all the courses offered at this school.

The instructor pointer segment is a pointer to the root of the Instructor Data Base. This segment is used to identify all instructors assigned to the school.

Figure 6 shows the segments contained in the Instructor Data Base.

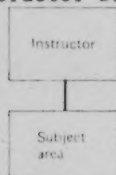


Figure 6 : A Typical Instructor Data Base

An instructor segment will exist for each instructor in a school system. This segment is used to identify the instructor and the designations to define specific attributes such as rank, tenure, teaching specialty, etc. The instructor load field is used to establish maximum teaching loads that an instructor can accommodate, such as number of course preparations, classes, contact hours, and students.

The subject segment is used to identify all the course sections to which the instructor has been assigned.

The Student, Course, Instructor, School and Test Data Bases, as presented, have not been subject to formal testing in a school environment. They are the result of a composite design effort, drawing upon the experience of several school districts that have successfully implemented in part these data bases. They are offered as a guide and not as a complete design. When used as such, in combination with such productivity tools as DB PROTOTYPE, these designs should prove useful to the school district.

ASSISTANCE TO STATE EDUCATION
AGENCIES: A COOPERATIVE VENTURE

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National Center for Education
Statistics

With the passage of the Education Amendments of 1974 (P.L. 93-380), the National Center for Education Statistics received a mandate to "assist state and local educational agencies in improving and automating their statistical and data collection activities." NCES has been working closely with state representatives through the Council of Chief State School Officers' Committee on Evaluation and Information Systems (CEIS) in designing a long-range program of assistance as well as in identifying priorities for near-term projects. This paper describes activities begun in response to the assistance mandate in P.L. 93-380.

The Assistance Mandate

The Education Amendments of 1974 mandated that the National Center for Education Statistics (NCES) shall "assist state and local educational agencies in improving and automating their statistical and data collection activities." To properly and fully address the needs of all state and local agencies, however, would require greater manpower and financial resources than the Center can hope to obtain in the present environment of tight budgets. Thus, NCES is working with state representatives in defining a limited number of high priority activities which will directly benefit the states, while at the same time having a positive impact on the local agencies.

Past Assistance Activities

Over the years NCES has provided assistance to state and local agencies in survey-specific areas through such activities as reimbursement to states for the cost of editing and processing data for NCES surveys, training at the state and local levels in relation to specific surveys, and at times the actual completion of surveys in the field. However, since these activities were designed to meet immediate data needs of the federal government, they did little to upgrade the internal capabilities of the states to provide data.

NCES has also developed the State Educational Records and Reports Series (more commonly known as the handbooks of standard terminology), which assist states and locals through the development of taxonomies and standard definitions. The handbooks are developed cooperatively

with state involvement, and this involvement is a critical ingredient in the success of the NCES Assistance Program.

The Planning Process

The Committee on Evaluation and Information Systems (CEIS) of the Council of Chief State School Officers was charged by the CCSSO with the responsibility of working with NCES in developing an assistance program in response to the mandate in P.L. 93-380. In September 1975, NCES met with a CEIS Task Force to begin this developmental effort. In order to get the assistance program underway it was decided that the Task Force would focus first on identifying priorities for near-term projects, while at the same time undertaking a comprehensive planning effort for the design of a long-term program.

Ongoing Activities

Currently the assistance program consists of five activities:

A project with the Council of Chief State School Officers (CCSSO) provides for close coordination between the states and NCES in activities which improve the collection and use of education data and which eliminate duplication and minimize respondent burden. A data liaison staff keeps states informed of various data requirements coming out of the Education Division, and works closely with NCES in planning improved services to state and local education agencies in the areas of dissemination and analysis. This project also enables NCES to obtain state input in the design of a program of assistance to the states. These activities are

accomplished through work with the CCSSO's Committee on Evaluation and Information Systems (CEIS).

Through the State-Level Information Exchange NCES encourages the exchange of technical tools and expertise. In Fall 1976 CEIS conducted a survey which assessed the status and needs of SEA statistical and automated information systems. An Information Exchange then made this data available in published form to the states. The publication has three clearly identified uses. First, it provides an excellent means whereby states can learn where specific information system activities are resident and operative. Second, by using the Exchange states can find where to obtain competent, short-term consultant services on such developments (at no direct cost to the state). Third, An Information Exchange will be used by NCES, in cooperation with CEIS, in planning and setting priorities for future assistance activities.

As part of this effort to facilitate the interchange of information and expertise among the states, NCES has also established a State-Level Personnel Exchange. A state seeking on-site assistance in statistical or automated information systems may utilize the Personnel Exchange to obtain first-hand knowledge of another state's activities in these areas. Additionally, states wishing to work together on a short-term project in statistical or information systems may apply through the Personnel Exchange for support of one or more workshops. NCES will pay the travel and per diem of state-level personnel who are released by their Chief State School Officer to travel. No fees or honoraria may be paid by NCES or the involved states. The Personnel Exchange is administered by NCES and coordinated through the CEIS network.

A Seminar Program each year addresses a topic of interest to state education agencies. The topics selected are designed to assist states in improving their data production or data utilization activities. A highly successful seminar was held in 1976 on Forms Management and Data Control procedures, and has generated a great deal of activity in state agencies. A second seminar will focus on the utilization of data collected through the Bureau of the Census' Survey of Income and Education and is being organized by state representatives. Future seminar topics will be selected through an analysis of the states' needs as expressed in the Information Exchange survey. NCES pays the travel costs for one person from each state and outlying area to attend these seminars.

The NCES State Educational Records and Reports Series (Handbooks of Standard Terminology) have long been recognized by state and local education agencies as valuable reference tools. However, until this year resources have not been available for projects to train persons in the use of handbooks in effective systems of records and reports. In order to encourage the adoption and implementation of Handbook II, Revised on Financial Accounting, NCES is undertaking the development of instructional materials to be used by professional trainers, or by state and local agency staff for self-help. The Center is also sponsoring workshops which focus on the training of state-level finance personnel. Travel and per diem costs for one person from each state to attend these workshops will be covered by NCES.

A design effort is underway with CEIS to develop guidelines and criteria for capacity building projects. These projects will focus on upgrading the internal capabilities of states to produce and utilize education data. Current activities focus on an analysis of the data in An Information Exchange, which displays information on administrative and management activities at the SEA, the provision of assistance by the SEA to external units, and specific SEA information system applications in the areas of finance, personnel, pupils, facilities and curriculum. An analysis of these data will define more precisely the parameters of the capacity-building projects within these broad areas.

Two types of awards are proposed under this capacity building program: (a) Special Purpose awards would be one-time awards to encourage the development of a comprehensive three to five-year State Plan for statistical and automated information systems. For states which have already developed such a plan, this award could be utilized to deal with a specific problem, such as training of SEA staff. (b) Implementation Projects would be larger financial awards of one-year's duration, potentially renewable over a three to five-year period, to support SEA efforts to build state statistical/information system capacities.

Future Directions

The projects described above represent a cooperative effort requiring a commitment of time and personnel by both CEIS and NCES. The CEIS Task Force on Assistance continues to be actively involved with NCES in the review of activities sponsored through the Personnel Exchange and in providing

state input to the design of seminars and a capacity building program. At NCES a recently expanded staff in the Federal/State Coordination Branch continues its design efforts, monitors established projects to ensure that they are coordinated through the CEIS network, and is responsible for ensuring that projects are consistent with the Congressional intent of the assistance mandate. Additional information on the assistance program can be obtained by writing to Donna Mertens, Federal/State Coordination Branch, National Center for Education Statistics, 400 Maryland Avenue, SW., Washington, D.C. 20202. [Telephone (202) 245-7813]

DATABASE SYSTEMS & DICTIONARY DRIVEN SOFTWARE

George McCollough
Texas Education Agency

A discussion of two data processing technologies, structured data storage (database) and "pre-fabricated" programming (dictionary driven) as utilized at the Texas Education Agency. The object of these efforts has been to shorten the construction time of new applications, lengthen their life span, provide facilities for better management of data as a major resource, and reduce the effort required for information reporting.

This discussion is divided into four parts. First is a brief introduction, including disclaimers and acknowledgements, to the environment and circumstances in which the Texas Education Agency's database system evolved. Following this, the discussion aims at presenting the design philosophy that determined (along with sheer necessities) the systems we installed. The final two parts of the discussion attempt a compressed statement describing the design of the data structuring mechanisms and the accompanying software.

INTRODUCTION

The data processing effort at the Texas Education Agency is moderately large with a significant amount of attention given to the requirement for information. As a state agency for the public school system (pre-kindergarten through senior high), the Texas Education Agency collects data about the activities of more than 1100 school districts which range from the very small (10-15 students) to the very large (185,000 students). This represents a considerable volume and variety of data. The data is collected by what are essentially manual procedures, which are initiated by funding programs of various sorts, legislated over the years, for a wide variety of reasons. The data at the state level then, does not represent a planned database, but rather a set of formal outputs which probably serve adequately the programs for which they were designed. To the database purist, though, the values so obtained do not represent basic measurements and observations which a database ought to keep so as to provide information continuously, even the unpredictable. Rather, the data more resembles

conclusions--the last word if you will--which was never planned at the time to go any further. The data is in isolated packages, some of it basic enough to use again; some of it meaningful only to some solitary collector; some of it gathered in, a dozen times or more.

So, the Texas Education Agency has been fertile ground for technical answers that promise to reduce the confusion and generalize the processing of even an unplanned database. The spirited issue of state financing of the schools, together with other urgencies, has forced us to install the herein described system with far too little data planning; a not to be recommended procedure, however common the practice.

The technologies discussed here may not be so important in another environment where voluminous data and multiplicity of use would be less characteristic of the institution than creations of someone's imagination. Nonetheless, we feel that there is some credibility to the thought that the principles behind what is said here is a definite improvement, and in some ways a necessary correction to the data processing state of the art.

We also need to point out that very little of what is described here is original with us. Our efforts have been primarily the business of adoption of ideas and designs developed elsewhere. The basic tenets of database design and modular programming were being established long before we queued in at a certain moment. The access methods used are all vendor supplied; at the moment we are using BSAM and VSAM from IBM, and TOTAL from CINCOM. We also utilize the String file technique via TOTAL which was developed by Statistics Canada.

We were introduced to dictionary driven software by Glen Harvey of DePaul University. The general maintenance system (database update) that we use is a rewrite of the DePaul system which we obtained at one stage of their development. The DePaul system that we plagiarized was itself a rewrite of the system at Amhurst University. There the basic concept originated under the direction of Paul Plourde.

The general extract system (database retrieval or report writer) was designed by Terry Nathan of the Texas Education Agency staff. The main design constraint was the necessity to conform to the requirements of the "dictionary" files which are created and maintained by the general maintenance system. Otherwise, the extract/report system was developed independently by our staff.

One more note of introduction. The systems discussed here are entirely Batch job oriented. Our involvement in the use of interactive terminals lags mostly because we simply have not gotten around to it.

DESIGN PHILOSOPHY

When we speak of database we first want to point to a change of attitude about data storage--from being just a factor within an application system to being considered a "pooling" of a major resource of the institution. This reemphasis gives data structuring a greater share of the design attention. The result is supposed to be logical structures of data values (the database) that are designed to display the principle assets and events of the institution. Ideally, the display would be an adequate one regardless of the point of view of the inquiry. Also, ideally, maintenance of the data values should be a more direct and natural procedure, because the data structures reflect a reasonably accurate view of the actual resources and issues of the institution.

Technically, database oriented systems aim at providing mechanisms for careful placement of the data as it is received for the purpose of general availability regardless of its ultimate use. Think of the difference between the way the airlines deliver baggage and the way the post office delivers mail (never mind how well). Because the passenger travels along with his luggage, he requires only operational assistance from the airline. This is not very different from the way we used to think of data storage, the data processors job was merely to keep the data intact until needed. The postal service system on the other hand cannot depend on the shipper to assist in handling

of the shipment. In fact, the shipper and receiver may be anyone, any time. Since the collection and the delivery is open-ended, it falls to the handling process to be well planned. A database environment is established for a similar purpose, and to do so uses a similar technique: the data handling procedures are designed so as to allow for general (and disconnected) data reception and distribution.

This brings us to the role of dictionary (or parameter) driven input and output. Since the requirement, in our opinion, is "as occurs" data reception (input) and "as needed" information delivery (output), storing the data cleverly is not all there is to the complete system. The mechanisms that interface with the user must be designed to transpose the particulars of the moment into and/or out of the common database. Previous application software approaches are not flexible enough to serve both the immediate interests of a user and the general good at the same time. Because of this, software development, in a few quarters at least, is evolving away from custom building of automated application systems toward mass production of "data processing" (which somewhat sarcastically implies that this was the intention all along). In these shops, more and more of the programming effort is going into the building of basic software components with less and less time spent on the implementation of individual applications. In short, the direction of software development has been influenced by many of the principles established in the industrial engineering discipline.

In any data processing shop, which here includes system's design, application systems can be, and in past have been, custom built if there is time. The time is gained if the user's expectations are relatively low, and the work is relatively uncomplex--three to five well defined applications and a few extras since the computer is there anyway. Custom building may also be the only way because funds, resources or management foresight are restrained for some reason. On the other hand, if there is time to tool-up, then systems can be built utilizing both pre-fabricated and custom units assembled as a standard process. This time is found because new systems are frequently ordered; applications can not be isolated but must reflect the actual interrelated activities of the institution, and/or the processes require a large degree of flexibility. Software development in the latter approach is thus done on two levels: the custom construction of tools, dies, and jigs, plus certain special units; and mass production (assembly) of the final applications.

Obviously there is nothing new about this idea. The concept of the stored program is simply tooling up to mass produce something. Whether a device is a tool or the end product depends only on where one is standing. Dictionary driven software is an expansion of the table assisted software idea which is a sophistication of an ordinary program which was almost always to some extent parameter driven. The reason for spending so much time talking about these "new" techniques is that the effect on the data processing service is significantly different, and to some, the right kind of progress. It was the next logical thing to refine after operating systems finally started working reasonably well.

Let us now talk about how we do it in one shop--first the structuring of the database and then the input and output standard processes.

DATA STORAGE

As has been indicated, what makes "computerized" data a database is both increased flexibility in the physical way in which data is stored (relative to the good ol' days) and a greater standardization of the way the data flows in and out of the database. Relative to past application designs, the data files in the database are a great deal more disjointed (along logical lines). The scattered data is made to appear integral at processing time by the maintenance and retrieval software that supports the database and which includes the "system" or processing logic files (the element descriptions, table descriptions, input descriptions, etc.).

We utilize five types of file structures: ordinary sequential files (BSAM), TOTAL supported Master, Variable and String files, and virtual sequential (VSAM) files. The following list briefly describes the application of each:

1. Sequential files (BSAM)--There are three reasons for using sequential files. The first, and perhaps a bad reason, is simply that there are many systems around that use sequential files. There is a lot of valuable data on these files. In order to include these data values in the database prior to that future day when everything is in a pure structure, which may never come, the data elements are described to the dictionary and can be maintained and queried by the full system. Another reason is that certain data, because of its infrequent use and large volume, is best stored on tape reels. And thirdly, a file may be required for a short term which does not justify the added difficulty in creating it otherwise.
2. and 3. TOTAL Master and Variable files--

We use these file types extensively because of their ability to structure data in a network fashion. A network structure is a more "natural" way to depict entities and events that are the substance of the "world" of a given institution. At processing time, that is, when data is gathered or information is required, the user normally conceives of the data relationships in a hierarchical fashion, i.e., where one entity is the dominant value or the starting spot and all other values are related successively in a subordinate, dominant manner as in the so-called (upside down) tree structure. But for permanent storage of data, the relationships are best kept in a network structure. A hierarchy is the more immediate point of view.

4. String files--A String file is physically a TOTAL Master file, but deceptively so. In a String file the data elements are treated as records and the records are treated as elements. As used at the Texas Education Agency, the String file offers the capability to add data elements (physical fields) about an entity type (known as the owner) continuously as easily as adding records to a conventional file. We use String files, one for each year, to store some of the values for the constantly varying data elements maintained on the school districts of the state. When a new element is required about a school district, the element is defined and values are loaded into the String file without re-organizing the file as would normally be required.

5. Virtual Sequential files (VSAM)--We use a VSAM file in one case where the requirement is for variable length records with random access. Used in this fashion, the VSAM file is an index sequential file with a two dimensioned hierarchy (index is segmented) and the data records variable in length. The application is the storing of the names for all of the professional personnel in the public school system. The names for so many people require variable length records, but a simple sequential file seriously restricts both the maintenance and retrieval capabilities.

Whether a file type and its companion access mechanism was originally thought of as fitting for a database or not, it should be chosen solely on the merits of its ability to store a certain kind of data better than any other type. As we have said, it is the processing software that integrates the many and varied data requirements that form a database.

DATABASE SOFTWARE

The main purpose of database software is, of course, to move data values in and out

of the physical storage media to and from the "logical world" of a processing program. The permanent structure of the database and the temporary form, required by the immediate process are never the same. So the data movement is really a matter of logical translation of the form of the data values. There is nothing new about this either. What is new, is, that the translation logic is removed from the processing program to become an independent process itself. This is done for the same reason that an interpreter is added to a conversation between two people who speak different languages; as opposed to requiring one of the two to first learn the language of the other. The whole complex of the translation system is called for brevity the DICTIONARY DRIVEN SYSTEM.

For convenience of discussion, we will begin with the elementary components and proceed to the more involved parts. Discussing the software system in this manner is not intended to imply that it was actually built with so logical a plan or that the development went as smoothly as might be inferred from so brief a comment.

The DICTIONARY DRIVEN SYSTEM is supported by a set of Master and Variable files which we will call for simplicity, the DICTIONARY. The DICTIONARY is a small database in itself, consisting of 12 files containing all the rules necessary for the translation process to occur. The basic components of the DICTIONARY are:

1. The Element Descriptions--This is one Master file in which a record is maintained for every element in the database. Within the record are such characteristics of the element as its "official" ID, description, class, length, decimal precision, record code, column headings for reporting, edit mask, etc. The Element Description file describes the format of each record of every file in the database; the format being how the elements are kept.

2. The Files Descriptions--These are a Master and a Variable file that describe all the files in the database and for TOTAL files, their relationships.

3. Database Component Descriptions--These are two files, Master and Variable, that describe the various groupings of files that make up the database modules used by TOTAL at any given time. That is, the database can be made to appear at execution time as many different databases each with different file configurations for execution efficiency.

4. I/O Module Descriptions--These three files, one Master and two Variables, are used to describe the User Program's data logic and its relationship to the actual database structure. As is discussed below,

the database is accessed for input or output by the General Extract and Maintenance System (GEMS) or by a user program through one or more I/O Modules. The I/O Module is a COBOL program that is built from the data in these three files.

5. Table Descriptions--A Master and a Variable File are used to describe the various Tables and their respective values. At execution time, a table can be loaded into main memory for use by the program internally or the table of values can be accessed conventionally as a file.

6. Input Forms Descriptions--Two files, a Master and a Variable, are used to describe the input formats of the incoming data when the database is being updated through the General Maintenance System (GMS, the update sub-system of GEMS).

The most elementary program module of the DICTIONARY DRIVEN SYSTEM is what we call the Database Manager Driver (DBMS). All data passing through TOTAL, the String file code, or the two sequential file access methods (BSAM & VSAM) is routed through this routine. Everything between this routine and the database is the vendor supplied Access Methods. This routine makes all version changes to outside supplied software transparent to every other program. It opens and closes files, produces a message log, keeps statistics, and does a few other basic housekeeping chores. Future enhancements will include "in-flight" recovery and database security (privacy).

The data next passes (from the point of view of retrieval) through an I/O Module routine which interfaces the format of the data as specified in the DICTIONARY with the logical format specified by the process of any particular execution. The I/O Module is the heart of the translation mechanism. The I/O Module's presence as a task within a particular job execution is controlled by an I/O Module Driver routine. The Driver's function is to call the appropriate I/O Modules as required by the User Program. The User Program may require one or more I/O Modules depending on how many logical records it requires.

Finally the data has reached (or is initiated by, in the case of an update) the User's program. There is only one more piece of red-tape, and that is, that before the User Program starts or terminates there is a routine to sign the program on or off the database. The main interest here is to insure sign off.

If the DICTIONARY DRIVER SYSTEM did no more than what has been described so far, we could with justification say that we had a database oriented design. The database access has been completely separated

from the application program, so the database can grow and change without affecting existing systems. Nor does the logic requirement of a particular process prejudice the structure of the database and thereby restrict its completeness. But we can go further if demand justifies mass production. Whether or not the processing program is primarily an input or output process, there are many common, recurring functions that are coded over and over with little change from one program to another. Even the order of the basic steps of an input program show few differences from other input programs. The same is true for output programs. Therefore, we ought to be able to mass produce application software. This is the fundamental purpose of GEMS, to function as an assembly line for the construction of the many different kinds of processes that are requested, especially as the computer is more and more used as an information center, and thereby considerably increasing demand.

GEMS has two halves: the General Maintenance System (GMS), and the General Extract System (GES). GMS or GES operate in the same relative position as the User program. GMS is for update, GES is for reporting. There is only space here to briefly describe the overall characteristics of each, but that we will try to do.

GES is a pre-compiler that generates a COBOL program from parameter statements given by the user and information obtained from the DICTIONARY. This information is edited and assembled into one of several "shell" programs. The resultant completed program is compiled in the normal fashion by the Cobol Compiler. The compiled program will then occupy the place of the User program described above.

Unless the program so generated is modified otherwise (which is comparably easy to do since it is a COBOL program) it will have conformed to two major design assumptions:

1. The reading of records from multiple input files will occur in a hierarchical fashion controlled by a base file, which is the file read first and is so read serially--first to last physical record.
2. The reading or creation of a single value for each of the output elements on the prescribed list marks the completion of the building of one output record and, unless the aesthetics are altered, represents one line of print on a page.

The three most important parameter statements are:

1. The element list statement wherein the user specifies the elements required from

the database and how they are to be printed on the page, or not printed but used as working elements. With the help of the DICTIONARY and standard printing defaults, a perfectly readable report can be had by stating only the Element IDs. Any of these assumptions can be altered of course, if required. The user may also specify element groupings for various kinds of "break" summaries (totals, percentages, averages, etc.). For instance the user may want certain element values totaled by campus, by district, and by county plus a grand total for whole state.

2. The file list statement wherein the user specifies the order in which the files, that contain the specified elements, are to be read; that is, the access hierarchy.

3. The logic interrupt statement wherein the user codes (in COBOL) program logic to be inserted at any one of a variety of places in the constructed program. It is here that the user customizes the report when required.

Another statement is used to describe the "run" type, i.e. whether the output is to be sorted or not, and/or printed or written to a sequential disk or tape file. Another is used to specify the heading at the top of each page.

Using the GES parameter statements is not difficult at all. We have been quite successful in teaching non-programmers how to produce information reports. Some people, though, do find the processing logic required of their report a bit hard to master. This is partly because our database is some distance from being ideal and partly because data processing abstraction just is not their cup of tea.

GMS, on the other hand, is a series of programs that functions directly in the update process initiated by input parameters and information in the DICTIONARY. The process of database update can be interrupted along the way in several places (called User Exits) in order to customize the maintenance run.

The fundamental job of GMS is to read data from an input format, convert this format into standard transactions (one for each element), post these transactions to various fields in the database, and produce a general transaction and error report.

By calling custom code in at the various exit points the usual maintenance process can be altered and/or enhanced in the following ways:

1. Input can be generated at reading time based on values found in the input stream.

2. Custom editing can be performed before update that will accept or reject the standard transaction.

3. Post update transactions can be created.

4. Custom reports can be made showing the successful transactions and errors in a special form as well as the condition of the affected database records.

GMS has one basic function, to update files in database. To an application system, though, GMS would appear to function on two levels. The first level being updates to the DICTIONARY, which is equivalent to describing the application design (or making changes to existing applications). To the application system, updating the DICTIONARY performs the same function as producing program logic. The second level consists of executing GMS to update the application system's files which is the same function as an application production run. GMS then, is one of those kind of tools that can be used to build other tools or a finished product.

Certain applications have been installed by using GEMS entirely. These applications use the customizing features of GEMS in varying degrees. Other, more complex applications use a combination of GEMS and the I/O routine approach. One of the most useful features of GEMS is the ability to be used partially by the application system at any time before or after it is in production. An existing application may wish to introduce a new input form. GMS is always available to make this change easy whether or not the application had used the system previously or not. GEMS may be used at any time to create new reports or reformat existing files as long as it is acceptable for the output to be sequential.

People have been talking and dreaming about information systems for some time now. It is our view that a good deal of foot-dragging has come from the data processing department. We have been slow to find new ways to perceive the storing of data and above all have been the last ones to approach software development in a systematic way. Perhaps it is natural for a shoe cobbler to have a hole in his sole, but in such cases no one else is affected. The data processor does not have this luxury, and fortunately there is enough of the machinery now available to liberate data processing system development from what has been, in some people's minds an overly specialized function.

DEVELOPMENT OF A CLASSIFICATION OF EDUCATIONAL SUBJECT MATTER

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Educational Management Services, Inc. of Minneapolis, under contract with the National Center for Education Statistics, is developing a subjective array of knowledge for all of education; pre-elementary through post graduate. The hierarchical classification will be used to identify and code instructional activities for local, State, and Federal reporting purposes.

In July, 1975, Educational Management Services, Inc. (EMS) was awarded a contract by the National Center for Education Statistics (NCES) to develop A Classification of Educational Subject Matter. The fundamental purpose of the document is to provide a classification of educational subject matter that currently exist from pre-elementary through postdoctoral studies. It updates subject matter elements as they are presently classified in local, State, and Federal reporting documents. It seeks to significantly enhance subject matter data record maintenance and reporting at all levels.

The document is not a classification of instructional programs, nor should it be used as such. It is a subjective array of the knowledge that is presently known to exist in American education. Instructional programs are discussed and listed in the Appendix to the document.

The document does not propose to serve as a framework for the organization of educational institutions or for the departments or divisions contained therein. The subject matter areas which constitute the framework for the hierarchical array were established subjectively in response to input from over two hundred people. Any resemblance to existing organizational structures is unintentional. Listed below are the twenty-two subject matter areas which constitute the mainframe of the array.

- 01 - Agriculture and Renewable Natural Resources
- 02 - Architecture and Environmental Design
- 03 - Arts, Visual and Performing
- 04 - Business
- 05 - Communication

- 06 - Computer Science and Data Processing
- 07 - Education
- 08 - Engineering/Engineering Technology
- 09 - Health Care/Sciences
- 10 - Home Economics
- 11 - Language/Linguistics/Literature
- 12 - Law
- 13 - Libraries and Museums
- 14 - Life Sciences and Physical Sciences
- 15 - Mathematical Sciences
- 16 - Military Sciences
- 17 - Philosophy, Religion, and Theology
- 18 - Physical Education, Health Education, and Leisure
- 19 - Psychology
- 20 - Public Administration and Services
- 21 - Social Sciences
- 22 - Trade, Technical, and Industrial

The classification has two major components; the first of which appears in two separate chapters and constitutes the hierarchical classification of subject matter for all of education. The first chapter contains coded descriptors for each of the twenty-two subject matter areas. The second chapter contains definitions of the subject matter elements. The numeric codes for subject matter descriptors and definitions are the same in each chapter.

The second component of the Classification contains the appendixes and follows the main body of the document. The appendixes represent other selected dimensions of educational information, and include level of instruction, type of instructional program, level of subject matter, and organizations sponsoring/providing instruction. These additional dimensions are to be used to amplify the recording and reporting of subject matter data. When combined with subject matter

elements, the additional dimensions add clarification and specificity to the data.

This classification of subject matter was developed in response to the needs of people involved in data gathering and reporting in all levels and types of educational institutions. Because of the rapid expansion of knowledge over the past 5-6 years, no existing document was perceived as accurately reflecting what is now being taught in American educational institutions. The need for identification appeared greatest in the technical disciplines found in public, private, and proprietary vocational-technical institutes and community/junior colleges. The lack of commonly accepted subject matter descriptors and definitions was particularly troublesome for educational agencies which are responsible for recording and reporting data for both elementary-secondary and post-secondary institutions. In some instances, more than one classification document had to be used which resulted in the data being neither comparable nor compatible within the agency.

Where classification documents did exist, their general applicability appeared limited. Some were directed to particular sectors or levels of education. In other cases, the terms used in classification were not defined which required the user to seek clarification from whatever source was at hand. The lack of uniform definitions and the resulting multiple interpretations lessened the applicability of the documents.

As students move from one educational setting to another, either vertically through graduation and advancement, or laterally through transfer or change in educational objectives, it is essential to have comparable data relating to the courses or subject matter they have completed. Data comparability does not require technical precision. It does require that the elements being compared have common features. A postsecondary institution must be able to compare the English courses completed in a secondary school with those it offers at initial levels within its programs. Similarly, a four-year baccalaureate college must be able to compare its subject matter offerings with those proffered by a student who wishes to transfer from a two-year community/junior college. In these and other instances, the ability of a student to move toward the attainment of educational goals is dependent upon the existence of comparable subject matter data.

In several instances, educational institutions make subject matter comparisons that demand more than judgmental assess-

ment. The characteristic of compatibility requires that two or more elements be technically related. They must be defined the same, be capable of being measured the same, and be aggregated and summarized the same. If someone is required to record and report the extent to which a particular subject matter is provided across the entire spectrum of education from kindergarten to postgraduate, the task can only be done if the descriptors, definitions, and hierarchical relationships between educational levels or settings are compatible. In addition, the terms and definitions must be concise and free of ambiguity.

Ideally, educational planners would like to be able to trace an individual's academic pursuits from early childhood to an undefinable point in a person's life when he no longer seeks formalized educational inputs. Considering the continuing educational programs now in existence, that end-point may occur at death. Only if students can be identified in common denominators can meaningful analysis be made of their flow through the educational continuum. Significant decision points, as when students flow into alternative courses of study, could be identified and dealt with by using a uniform classification of subject matter. Overall educational objectives could be assessed on a time-line in accordance with the completion of specific subject matter competencies. At present, many students become lost to gross analytic assessment when they move from one educational sub-system to another; as between a professional school and a continuing professional education program. A well defined discipline that could be universally recognized with no qualifying concern for the nature or level of the student would be extremely useful in longitudinal studies.

There appears to exist a significant decrease in the "segmentation" of education; both in age and level of competency. Many of the "rites of passage" from one educational level to another have been erased to accommodate student enrollment at multiple levels; or to allow for competency based education. Subject matter data must not only be continuous, but contiguous as well so that institutional student data can interface from one educational setting to another. A uniform classification of subject matter, unencumbered by territorial descriptors, will facilitate student entry, transfer, exit, and re-entry.

The reporting requirements that are imposed by law on local institutions and State and Federal agencies dictate the need for a standardized classification of subject matter. A uniform classification

for all of education would promote rapport among a wide range of people having different interests and needs related to subject matter and other aspects of instructional programs. Such characteristics as common coding and structure would facilitate the collection and recording of data which is the first step of the reporting process.

Standardized terminology will expedite communications about subject matter and related data and will make the Classification particularly useful to Federal, State, and local governmental and educational agencies; colleges and universities; churches and synagogues; business, industry, and labor; adult education organizations; proprietary career schools; and others involved in administering, operating, evaluating, and funding educational programs.

A uniform classification of subject matter can serve a very useful purpose as a reference document. The person using the Classification could discover not only the many elements of instruction but also the hierarchical relationships that tie those elements together. This would be particularly beneficial for the student who was exploring alternative courses of study in a variety of institutions.

A uniform classification of subject matter, while not ensuring elimination of the stigma of institutional identification, might well serve to help legislators, educators, and the public to think in terms of program and subject matter categories and not only in terms of institutional characteristics.

Assisting EMS in the development of the Classification was a twenty-member National Planning Council which advised NCES and EMS on the project approach, the content and format of the document, and the numerical coding and classification structure, as well as the subject matter entries and the additional dimensions. The National Planning Council was selected in 1975 by NCES upon the recommendation of EMS and others. Nominations were requested from a variety of educational associations whose members represented levels of education; types of educational institutions; and/or educational agencies, consortia, or coordinating bodies. EMS prepared a list of candidates that featured a broad geographic distribution and equal representation of major educational affiliations. The twenty members were then selected from this list by NCES.

Also involved in the development process were twenty-one Ad Hoc Subject Matter Committees whose members advised EMS and

NCES on the content of the document, its structure, and the definitions for the subject matter entries. Nominations for membership on the Ad Hoc Committees were sought from educational associations whose members were affiliated with specific subject matter areas. EMS listed the nominees under one of twenty main-frame categories and attempted to ensure geographic distribution and representation by level and type of educational institution. The committee recommendations were then sent to NCES for selection.

In addition to the members of the National Planning Council and the Ad Hoc Subject Matter Committees, several other individuals provided input to EMS and NCES in clarifying and defining subject matter areas. NCES established a committee in Washington made up of people within the Center as well as from other Federal agencies involved with educational data collection and reporting.

The document was produced in three drafts prior to submission in final form to NCES. The first draft was produced in the fourth month of the project following an extensive review by EMS staff of the literature and of existing systems for classifying educational data. Federal and State classification documents and reporting forms were perused as were those of the United Nations (UNESCO), of regional accrediting bodies, of private agencies, and of professional societies. Because of the comprehensive nature of the classification, the first draft was more than an amalgamation of existing documents.

After the first draft was prepared, it was sent to all members of the National Planning Council and of the Ad Hoc Subject Matter Committees along with several selected readers. The Council and the Committees then met to discuss the draft with EMS staff members and to suggest revisions and modifications. Following an extensive period of review and modification, EMS prepared a second draft eight months after the first. Again the document was submitted for review, and again the National Planning Council and the Ad Hoc Subject Matter Committees were called into session. The second review led to the production of a third draft which was mailed out six months after the second. That document is currently undergoing review and modification by the National Planning Council, the Ad Hoc Subject Matter Committee, and others.

A final copy of the Classification of Educational Subject Matter will be prepared by EMS and submitted to NCES in July, 1977. NCES will then conduct a national field test of the document in

accordance with existing policies and procedures. Following the field test, the document will be released for use throughout the American educational community.

The National Planning Council met twice in Washington and for a third and final time in Minneapolis. The meetings lasted two and one-half days, and consisted of five sessions. Each session dealt with a specific aspect of the project or of the document and were identified as follows: project background and approach; introduction section of the document; coded classification and definitions of subject matter; appendixes, index, and glossary; and summary and Council recommendations.

Prior to the Council meetings, EMS developed a set of questions and concerns that were to be confronted by the members. The Council was then divided into three work groups who dealt with the questions and then reported back to the rest of the members in a large group setting. Following each Council meeting, the remaining questions and concerns were documented by EMS staff and presented to each of the Ad Hoc Subject Matter Committees.

The Ad Hoc Subject Matter Committees were called into session three at a time. The meetings lasted two days. Two groups of committees met within a week so that a total of six committee meetings were held over a five day period. Each session began with a brief introductory presentation of Planning Council concerns and assigned review tasks. The three Ad Hoc Committees then met separately for the rest of the session.

Committee members were asked to first direct their attention to the coded structure in Chapter II. They were asked to review the substance and form of the draft material prepared by EMS. If elements were missing, they were to be introduced by the committee. If the draft contained inappropriate or outdated elements, they were extricated; either to be discarded or considered elsewhere in the document.

Potential conflicts with other subject matter areas were identified early. If an element was considered an application of another subject matter element, it was attached to the one from which it had its genesis. Business statistics was classified under Mathematical Sciences rather than under Business. Economic History was, however, classified under Economics rather than under History. In some cases, the placement was made arbitrarily after consideration of subjective influences.

If a subject matter element were thought to consist of two equal parts of different elements, it would be included under the section called Multiple Subject Matter (Interdisciplinary). Several humanities elements composed of such things as art, music, and literature were treated thusly.

If two committees "laid claim" to a subject matter element, it was treated in one of two ways. If the element were acknowledged to have its genesis in one subject matter area, but considered essential to the composition of another, it was listed in both areas, defined in its genetic category and cross-referenced to the other area. In the second instance, the element was listed in Chapter II under both contesting areas. It was defined in Chapter III, however, under the designation of "Duplicate Entries." When an element was treated in this way, it had to first meet certain conditions. Only one subject matter descriptor and definition were suggested, and the element could be justifiably placed in two or more areas.

The primary procedural objective of the project was to obtain declared consensus from representatives of all levels and types of education. It was acknowledged from the start that total agreement on the content and definitions would not be possible during the project's two-year timeframe. A project such as this which classified subject matter into discrete categories caused concern among several educators. When dealing with the substance of one's academic department, division, or school, some participants preferred to have aggregated together those elements with which they were associated or over which they exercised control or jurisdiction. Initial resistance existed among those who saw their affiliated subject matter dispersed into several subjectively established categories.

EMS staff stressed to the members of the Ad Hoc Subject Matter Committees and the National Planning Council, the importance of genetic categories, or single entries, and of the integrity of subject matter. Though not rigidly defined, the Committees were asked to develop their areas in accordance with five criteria. The first was the criterion of age. The subject matter elements had to have been in use long enough to be commonly understood and accepted throughout the educational community to which they were appropriate. New areas of knowledge were included if they were presently recognized by all members of the committee. Esoteric descriptions which were self-serving attempts to retitling venerable subject matter elements were discarded.

A second criterion was that of universality which suggested that the subject matter element be found throughout a broad range of educational settings. This would exclude, for example, limited offerings in a highly restricted program to which minimal resources would be devoted. Universality could apply in several ways. Certain subject matter could be found throughout the nation at specific levels or within special types of institutions as is the case with Law. On the other hand, subject matter may be universally found throughout all types of institutions, but within a restricted geographic area as with Marine Biology.

The criterion of magnitude was also considered, although its application was often arbitrary. Magnitude could be applied to numbers of students enrolled, number of classes taught, amount of resources consumed, or any other characteristic of size or number. At the same time, an indication of great magnitude would not of itself dictate the way in which subject matter would be handled. Even though a course may be taken by every elementary and secondary student in the nation, it might still be subsumed under a broader designation.

The fourth and fifth criteria were natural and artificial relationships. Subject matter could be classified within one major area because of natural relationships with other elements in the same area. Thus, Chiropractic, Dentistry, Medicine, and Veterinary Medicine were all grouped together because of their concern with Health Care/Sciences. On the other hand, subject matter may be grouped together because of incidental factors, or artificial relationships. In either case, the subjective judgments of the committee and Council members in combination with that of EMS staff formed the array of subject matter. Surveying, for example, is incidentally related to Engineering in much the same way as Mathematics or Physics. It is reported under Engineering, however, because there appears to be a relationship that may at best be artificial.

The program-vs-subject matter distinction proved to be very troublesome to many of the Ad Hoc Committee members. A major reason for this is that most of the reporting now being done relates to instructional programs.

For the purposes of this project, an instructional program was defined as a plan of one or more courses or combination of courses and experiences that are designed to accomplish a predetermined objective or set of allied objectives such as qualification for advanced study, qualification for an occupation or range

of occupations, or solely to increase knowledge or understanding. By definition, instructional programs relate to educational outputs.

Instructional programs can and should be differentiated from subject matter which represents the substance of knowledge. Instructional programs, by contrast, represent the form or style by which knowledge is transmitted and received. Instructional programs can be defined in terms of the subject matter of which they are composed, but they are also structured around other experiences such as internships, practicum, etc.

In identifying subject matter elements, Ad Hoc Committee members used instructional programs as a reference point. They were encouraged by EMS staff to specify what a person needed to know to successfully complete an instructional program, or to qualify for a vocation or profession. It was difficult for some to see that a sculptor may need the same knowledge of welding and may take the same welding courses as a body and fender repairman.

Even when the distinction between programs and subject matter was made, some committee members were reluctant to release subject matter elements to other committees. There was a tendency to keep all program related elements in the same subject matter area. An instructional program in Nursing is a good example of the concern facing the Committee members.

To describe a program in Nursing according to its subject matter composition would quite likely require the aggregation of elements from the subject matter areas of Communication; Language, Linguistics, and Literature; Mathematical Sciences; Life Sciences and Physical Sciences; Social Sciences; and Health Care/Sciences. Some committee members felt constrained by this exercise and sought instead to list all program-related subject matter within one area.

The greatest amount of concern over program-subject matter distinctions came from representatives of the postsecondary education sector. The vast majority of reporting in higher education is now done by programs and the major classification document now used is the HEGIS Taxonomy of Instructional Programs. There is no nationally recognized reporting structure of subject matter, nor is there a reporting demand for subject matter data. The tendency to focus on programs instead of subject matter was not, therefore, unusual or unexpected.

In summary, the project to develop A Classification of Educational Subject

Matter seeks to satisfy the need for a national data recording and reporting structure. In order to ensure responsiveness to the needs of the entire educational community, individuals from all levels and sectors were invited to participate in the construction of the document. A twenty-member National Planning Council advised the contractor, Educational Management Services, Inc., on the project approach and on the content and format of each successive draft. Twenty Ad Hoc Subject Matter Committees lent their expertise to the delineation of subject matter elements and definitions.

EMS sought declared consensus from those assisting in the project as well as from those who were identified as potential users of the Classification. The finished document will serve as the only comprehensive array of knowledge as it is currently presented in American education; pre-elementary through postgraduate.

EFFICIENT ADMINISTRATION OF INSTRUCTIONAL PROCESSES

OR PUT THE COMPUTER TO WORK

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Many educational institutions fail to make optimum use of computing facilities because of a failure to recognize activities which could be more efficiently performed by a computer. The first task to putting the computer to work is discovery. After areas of inefficiency have been discovered it is necessary to define the activities necessary to make the operation more efficient. If discovering and defining have been successful, solving becomes a managerial task. Solving the problem involves obtaining the proper interaction between the problem, the software, and the hardware. Efficient administration through the use of a computer does not begin with the computer itself rather it begins with the eyes and mind of an effective administrator.

"Why didn't we think of that?" "Why didn't we think of that before?" "Why did we wait so long to do this?" All of us have at one time or another heard these questions raised. Additionally you have heard such statements as "You are not really getting the best use of.." or "That's really not very efficient."

In the area of educational data processing, it is not uncommon to find educational institutions with more than adequate hardware and more than inadequate usage. A large metropolitan school district indicated that they had an inhouse computing system. Later in the conversation it was discovered that they were busy hand searching through all their teacher personnel files for someone who could teach a course in sex education. Another school district never considered using their computer to generate teacher pay schedules in preparation for negotiations. In large universities where computer facilities are in abundance many departments never consider extensive administrative uses. Subsequently problems-inefficiencies-exist. Before considering solutions it is necessary to discuss problem recognition.

Problem Recognition

Almost everyone begins problem solving when they have received some sort of negative stimulus. Usually these negative stimuli are strong enough to be recognized by most administrators. However, the intent here is to call attention to negative stimuli which are perceived by a relatively smaller group of administrators. This type of

administrator may not exist in your particular organization. The intent is not to define that type of administrator, but rather to increase others sensitivity by showing the conditions under which he operates and the results of his work.

Task analysis should be a frequent occurrence when working toward efficient administration. Studies as extensive as those by Frank and Lillian Gilbreth are not suggested. One should begin by seeking recognizable negative stimuli. If insufficient time causes tensions, these can be felt; repetitious day to day operations can be seen; tedium because of repetition, can be understood. Continuously changing conditions which make a report obsolete by the time it is completed are also a sign of an ineffective administration.

If one is very sensitive to negative stimuli, he is more likely to perceive inefficiency earlier than some of his colleagues who are less sensitive. Those insensitive to negative stimuli often have inefficient administrations just as do those who see only one alternative as a solution to a problem. Efficient administrators recognize problems when everything is running well. Effective administrators know that there is always a better way of doing something. The theme of this conference says that educational data systems is a function of hardware, software and peopleware. In efficient administration of instructional processes-in putting the computer to work-peopleware is the first factor.

People must be aware of problems; they must be sensitive to negative stimuli before efficiency is obtained. How does this happen?

Continuous action to remove or strengthen the weakest link in an organization is often an effective means of making it more efficient. Before one can define a problem, let alone solve it, it is necessary to recognize it. One might begin by writing down what is bad about the operation. No matter how well an organization functions there are always tasks that are not performed as well as others. Listing these tasks from least to most efficient is recommended as a beginning for improvements. At this stage it is not necessary to specifically define the problem; it is not necessary to consider if there is a solution to the problem; it is only necessary to recognize those things which are causing some sort of tension or boredom, those things which are constantly repeating or those things which are constantly changing. Additionally, one can broaden ones view and increase awareness by attending appropriate meetings where others share their experiences or by viewing other administrative operations which are similar in purpose to ones own. Once a problem or inefficiency has been recognized it is then necessary to define it.

Problem Definition

Defining a problem involves writing down specifically what is wrong with the current operation. When recognizing problems, tasks were written down, here the specific details of the task are to be analyzed. This does not require any consideration be given to solutions to the problem. However, analysis of a function does require that the objective of the function be clearly understood. If the objective is to produce a report by noon every Wednesday and it is actually finished on Thursday afternoon, problem recognition is easy although problem definition may not be. If the report is completed by noon on Wednesday, negative stimuli are at the threshold level. It is at this level that administrators are separated. The stimulus sensitive administrator questions whether the report could be better, easier or faster produced. Lack of sensitivity biases the writing of what is wrong, what could be better, about the activity in question. Once the problem has been defined then seeking possible solutions begins.

Problem Solving

There may be many types of solutions to your particular problem, but because of the nature of this particular conference let us assume that the solution involves the use of computing facilities. The computer is not always a solution.

It is possible that computerization can be a solution that creates more problems than it solves.

However if one has decided that computerization is a solution to be considered, the hardware and software factors now enter the equation. It will be assumed that hardware availability is already a given in this particular environment. Solving a problem requires the development of an algorithm or model that is to be used in the computerization and software development. It also requires knowing the extent of programming necessary and the cost of both programming and running the final programs. Administrators who are not aware of the limitations and potential of a computer may find a role reversal problem. The computer becomes the master and the user the slave. In this situation computerization gets a bad reputation and future applications become more difficult. Likewise administrators who delegate computerization decisions to persons who know nothing about the administrative function being computerized could find themselves "computerally" inefficient. After all the work of problem recognition and description selecting the wrong alternative solution or failing to properly implement the solution can negate the entire project. The negative stimulus which results will be obvious to even the most insensitive administrator.

Computer Applications

In order to more clearly reveal this procedure of discovering the problem, defining the problem and solving the problem several examples of this system that are currently at use in the Division of Mathematical Sciences at Purdue University will be pointed out.

Quite unintentionally it was discovered that the procedure for publication of teaching assignments and class locations resulted in a product that was obsolete at the time it was produced. Ten or twelve changes were made daily for the first week of each semester. The operation required a clerical person to work overtime on the Sunday preceding the beginning of the semester to type a list of assignments. This reporting of teaching assignments had been done this way for years. Those who were acquainted with the process never gave serious consideration to doing it any other way. The inefficiency of this procedure was obvious to an efficiency sensitive administrator. As a result of discovering and defining this problem it is now a 95% computerized operation. The individual responsible for scheduling instructors merges computer cards containing the instructors name on one card and a teaching assignment on another and the computer produces the desired list.

An updated list is produced as often as twice a day during the first week of the semester. It was also discovered that in this system 200 instructors were notified of their teaching assignment through memos that were typed and sent to them. It seemed only logical and efficient that since the computer knew who was teaching that the computer itself should write a memo to the instructor telling him of his teaching assignment, that too has been accomplished. Many additional uses have been found for this computerized operation. It in turn has been analyzed for weak links and changes are planned. For example, keypunching changes can be replaced by an on line terminal with an edit system.

Every summer 60 students per day for 20 days are tested on their mathematical competency. Four years ago reporting of the test results required a clerical staff member to alphabetize the names, type up the resulting report, which contained the name, social security number and score and whether or not credit was received, reproduce approximately 90 copies of the report and distribute to counseling offices around the university. Since typing the names was necessary for this report, keypunching would be no more difficult. The computer could much more rapidly sort the names and produce the necessary copies for counselors than could an individual. As a result an operation which had been done the same way for 20 or 25 years was radically changed. The same types of things were still being done but now much of the work depended on the computer and as a result the work was done much faster. A reassessment revealed that distribution of results is a weak link. Computer terminals in counseling offices will improve that problem. A pilot study has already been conducted. Five seconds after the data is read into the computer immediate retrieval is possible by any counseling office. Distribution used to take about one hour.

A year ago at the AEDS conference I reported on another project that had been developed within the Division of Mathematical Sciences at Purdue. The university each semester hand produces a report on delinquent students. The Department of Mathematics decided that this report was inadequate in that it did not contain sufficient information. Therefore, it was their intent to produce their own more detailed report. For the first two years this report also was done by hand. It required three people working approximately three weeks to accomplish the necessary tasks. The recognition of the inefficiency of this operation resulted in a computerized process which has reduced the clerical time to approximately two

hours. Computerization has not only reduced the time factor it has also prepared a better report.

In the Division of Mathematical Sciences at Purdue University nearly 5000 students each semester make a change in their course enrollment. Notifying instructors of these changes had always been a tedious job. Each notice of change was received on a single sheet of paper. The name of the instructor and his office had to be looked up and then each individual sheet distributed. Through the use of the computer it was possible to write notices to the appropriate instructor. Since the data had to be keypunched for another project it was a simple procedure to feed the cards into the computer and have it write one message per instructor indicating all necessary changes on his records. The computer, knowing the teaching assignments was able to put the instructors name and office on the notice. This procedure has made possible the construction of an interactive system to supply current enrollment counts for all sections of all courses.

The Division of Mathematical Sciences has found many ways to use the computer to increase the efficiency of its administrative operation for instructional processes. Efficient administration of instructional processes requires that peopleware are aware of the specific details of their organization; aware of them to the extent that they are able to determine the weak points even though they may not be recognizing negative stimulus in this regard. An awareness of potential solutions is also necessary for increasing efficiency. Likewise it is very important that the administrator who seeks to make his organization efficient through the use of the computer understand that it is the computer who is the slave and not the master. It should not be necessary to adjust the organization to fit the computer but rather to use the computer to make the operation more efficient.

IN - COMPASS

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ABSTRACT: The Region XIX Education Service Center's Interactive Comprehensive Multi Processing Administrative Student System (IN-COMPASS) has been developed to provide school administrators, teachers, and students with a controlled, complete, and accurate K-12 information system through efficient utilization of multi-processing computerized techniques. The system operates on a Digital Equipment Corporation DEC System-10, using Applied Digital Data Systems 520 and 580 interactive communication CRT's, National Computer Systems Sentry 70 Optical Scanner and batch mediums for user Input-Output. Phases of information include: Demographic, Pre-registration, Simulation (scheduling), Completed Registration, Drop and Add, Registration Statistics, Grade Reporting, Grade Changing, Grade Statistics, and Administration Statistics.

IN-COMPASS is a self contained series of procedures and programs that provide school administrators a variety of options in performing complete registration, scheduling, and grading.

The system offers very fast registration, and simulation; flexible course, section, teacher and room processing; a variety of administrator--student-oriented report options; complete interactive maintenance of files throughout the system; and comprehensive grade processing.

Written largely in the COBOL programming language which meet the ANSI-73 standards, the system was developed for the Digital Equipment Corporation DEC-10, TOPS10 operating system.

The simulator was acquired through Digital Equipment Corporation and is written in the DEC-10 assembly language, MACRO. Region XIX Education Service Center has developed significant modifications to the skeleton system.

The initial operation of the system is to establish the school numeric identification and build the initial file headers. This is accomplished via interactive processing in the Data Processing Center. Header information for each school files contain school name, valid grades (K-12), maximums of terms (1-4), term length (0-10), beginning class period (0-10), and class period length (0-10). Completion of this function establishes the school as a user of the system. The following are the phases of the system:

PHASE I - DEMOGRAPHIC: Mass-file-building is accomplished through the use of the "Feeder Student Demographic Data" form (FORM #1). It is completed and returned to the Data Processing Center for assignment of student numbers and processing. The "home room" field is used for

requested distribution sequence of "Student Request Scanner" form (FORM #2). To add a student after mass processing, the same information is entered through the interactive CRT process. Each school assigns the student number from a block of user numbers in this processing.

PHASE II - PRE-REGISTRATION: Mass pre-registration is accomplished with the use of the "Student Request Scanner" form (FORM #2). Each student, along with administrative counseling, is required to mark (bubble) in their course request. This form is returned to the Data Processing Center for scanning and processing. Preliminary statistics are produced containing course tallies and errors.

Course tallies are returned to the school which are administratively analyzed to determine the number of course sections and their seat maximums. After the course section files are built, student request are interfaced into the registration portions of the system. Reports are requested for those students requesting courses which did not make and student "Course Request Verification Tickets". From these reports preliminary course request changes are made through the school display unit. Subsequent term registrations flow into the system by producing and processing "Student Course Request" forms and then continuing to the subsequent phases.

PHASE III - SIMULATION: After all course request changes are made and seat maximums are set, the school request through their CRT display unit a "Simulation". A simulation on the average runs from five to eight minutes and five K words of core for a school of twenty-five hundred students. Outputs from the simulation are the number of students processed, number of students completely scheduled, number of course conflicts, and

number of time conflicts. The simulator goes through three passes:

- A. Prepass - loads all request and verifies them to the course file.
- B. Mainpass - simulates request to the course file.
- C. Partialpass - simulates course and time conflicts for partial scheduling.

Each student is internally coded as completely or partially scheduled.

PHASE IV - COMPLETED REGISTRATION: As a result of simulations, student "Conflict Tickets" are produced for those students receiving partial schedules. From the tickets, students adjust their course request, and changes are made through the school CRT placing them into open course sections.

At completion of this process, all students are considered scheduled and student "Section Tickets" are produced for distribution to the students. Along with the tickets, the school administrator can request various reports of tallies, course-section loads, teacher loads, and room utilization reports.

PHASE V - DROP AND ADD: The process of Drop and Add is accomplished through the CRT's by each school. Drop and Add continues until the grade reporting cut-off date. Interactive CRT maintenance allows for add, change, re-admit, inquire, and deleting of student and course records. Also at this time the school begins preparing their files for the coming term.

PHASE VI - REGISTRATION STATISTICS: Various hard copy reports can be produced and each in a variety of sequences, which give complete and comprehensive results.

The following is a list of registration statistics available;

- * - Course Conflict Matrix List
- * - Course Enrollment List
- Selected Course Enrollment List
- * - Course Tallie List
- Scheduling Student Course Request Tickets
- Scheduling Student Directory List
- Scheduling Student Section Tickets
- Section Enrollment List
- Selected Section Enrollment List
- Section Load Report
- Teacher Load Report
- Room Utilization Report
- * - Minimum Section Load Report

* These reports can be produced for interactive CRT viewing as well as hard copy.

PHASE VII - GRADE REPORTING: Grade reporting is a phase that starts once the term begins. Changes for student schedules must be entered through the interactive CRT's on a daily basis. Also grades given prior to the end of the grade cycle can be entered at this time. About three weeks before the report cycle ends, "Scheduling Section Enrollment List" are requested and produced by each school. These list are given to the teachers for one final update before grade sheets (FORM #3) are

requested. The method used for changing enrollment data is up to each school, however, all enrollment changes should be processed into the files prior to the cut-off date. Once all corrections are made, request for producing grade sheets are made by the school.

When the pre-grided grade sheets are received at the schools, usually the week of the exams, they are then distributed to the teachers. The teachers mark (bubble) the students grade in the appropriate spot on the marking sheets. After the grade sheets are checked, they are returned to the Data Processing Center for scanning and processing. Preliminary reports are produced depicting all marking errors and missing grade sheets. After correcting marking errors and adding missing sheets, grades are posted to the files.

At this point, the school may elect to produce reports in various manners. Usually the Report Cards and Report Card Proofs are produced. However, grade changes may be made through the CRT's prior to producing Report Cards. Report Cards are produced in a variety of printing sequences.

PHASE VIII - GRADE STATISTICS: Various hard copy reports can be produced and in a variety of sequences which give complete and comprehensive results.

The following is a list of grade reporting statistics available:

- * - Report Card Proofs
- Graded Section Enrollment List
- Grade Distribution List
- Incomplete/Failure List
- Honor Roll List
- Grade Labels

A. Grade labels are produced to affix on the student permanent records.

* Each students' complete term grade reports can be viewed via the display unit.

PHASE IX - ADMINISTRATION STATISTICS: From initiation of the student files through the grading of his classes, it is imperative that administrators chart the status of the school's progress. A series of reports exist to assist the administrator in this continuing task. These reports are::

- Course Enrollment List
- Course Tallie List
- Section Load Report
- Teacher Load Report
- Room Utilization Report
- Grade Distribution List
- Incomplete/Failure List
- Honor Roll List
- Grade Labels
- Complete School District Course Enrollment List

These reports can be requested by either each school's administration or by the School District Administration.

IN-COMPASS is still new enough to preclude strict cost accounting. However, the savings in personnel time as a result of interactive CRT computerized

student accounting might be subtracted from the budget cost. Based on current accounting statistics, Region XIX Education Service Center is offering this complete and comprehensive system for much less than our previous system. Factors such as CRT operation competency with the system procedures can vary this cost greatly.

Future phases being developed currently are Attendance Accounting and complete Transcript Record Accounting.

All features of this system can be tailored to meet the requirements of any school district and/or school, as deemed necessary.

REGION XIX EDUCATION SERVICE CENTER

Punch in
all cards

SCHOOL 9 11

FEEDER STUDENT DEMOGRAPHIC DATA

1

Student Name:

Last 17 First 32 Initial 47
Sex 49 Birthdate 50 55 Scheduling Grade 56 57
Home Room 58 63

2

Student Address:

Street Number 17 22
Street Name 24 42
ZIP 43 47

3

Parent Name:

Last 17 31
First 32 46
Initial 47

Relationship to Student

F = Father 49
M = Mother
G = Guardian

Telephone Number 50 56

Form #1

STUDENT NAME _____ SCHOOL NAME _____ DATE _____

[illegible]

COURSES TO BE ADDED: LIST THE COURSE NUMBER IN THE BLOCKS BELOW

Figure 1 consists of seven vertical columns, each labeled 'COLUMN' at the top. Each column is a 10x10 grid of cells. The cells are either filled (black) or empty (white). The patterns of filled cells vary across the columns, representing different column layouts. The first column has a single filled cell at the bottom. The second column has a single filled cell at the top. The third column has a single filled cell at the top and a single filled cell at the bottom. The fourth column has a single filled cell at the top and a single filled cell at the bottom. The fifth column has a single filled cell at the top and a single filled cell at the bottom. The sixth column has a single filled cell at the top and a single filled cell at the bottom. The seventh column has a single filled cell at the top and a single filled cell at the bottom.

Form #2
NCC Form-0000 0375-04

PUPIL NAME	RELIGIO		FINAL GRADE	ABSENCES	COURT
	TEST	OT			
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SCHOOL
 SECTION

Page 4

INNOVATIVE TEST REPORTING SYSTEMS

Bradford Burris
Scott, Foresman & Co.

During the winter of 1976/77, an informal survey was conducted among the 100 largest public school systems and regional centers to learn about new formats and innovations in school test reporting. The survey indicated that schools are trying to (1) report more trend information, (2) develop reporting procedures for locally developed criterion referenced tests, and (3) make better use of item analysis data. Little or no activity is apparent in helping students or teachers make better use of test results. This session describes results of the survey, displays submitted examples of new reporting formats, and discusses needs in test score reporting.

During the last few years standardized tests have been sternly criticized as being inappropriate and biased in measuring outcomes of today's education. Defenders of standardized testing maintain that it isn't the tests themselves that are at fault but the way in which the test results are misused.

The form that test results usually take is originally designed by the developer of each test. Generally, standardized tests report scores in terms of statistical numbers, termed grade equivalents, percentiles, stanines, standard scores, bands, percent-below, etc. These numbers then in turn are expected to be interpreted by teacher, student, Principal, researcher, or newspaper reporter according to accepted procedures and recommendations made by the test developers and measurement statistics experts. Then, supposedly, some action takes place whereby curriculum is changed, resources are reallocated, career decisions are made or some other productive use is made of the test results.

The last two phases often do not occur, however, because neither teacher nor public take the time to interpret the massive data supplied them.

Survey Conducted

With the expectation that the larger school districts with their depth of resources in computers and research techniques are developing innovative ways of reporting test scores to counter recent criticisms and help test users make better

use of the results, this reviewer undertook a survey during the fall and winter of 1976/77 to determine what unique systems for reporting test scores to teachers, districts, public, administrators, etc., are being developed.

An informal survey with the following three questions was sent to the approximately 100 largest school districts and data processing centers:

1. What tests do you use?
2. What unique reports do you develop?
3. What is your biggest unsolved need in test results reporting?

A cover letter discussed in very general terms what was being sought. "...Not the usual list reports of GE's, PR's, and FD's, but more innovative interpretive reports, growth records, monitoring systems, diagnostic needs analyses, etc. Reporting formats designed to answer questions on accountability, teaching prescriptions, cost effectiveness, comparative status, etc., for student, teacher, parent, school board, public and the like."

The letter and informal questionnaire were sent to the Director of Testing and also to the Director of the Data Processing Department, where presumably tests are scored and reports generated. The letter and questionnaire were purposely kept open-ended and general to leave a broad spectrum of possible responses.

Response

Almost one-half of the districts and centers responded. Some answered that they had no unique reports. Those not replying are presumed to fit one of the three categories:

1. Not interested
2. No unique reports
3. So busy developing unique reports that they have no time to respond.

A few phone calls to several non-responders indicated that the second category generally prevailed. Anyone developing unique reporting systems seemed interested in mentioning them no matter how busy they were.

Survey Results

The three areas of test reporting that seem to be receiving the most attention are:

1. Building and system-wide reports, showing more longitudinal trend information and including factors other than just test results.
2. Objective-based, goal-oriented systems for reporting locally-developed criterion-referenced assessment programs.
3. Attempts to summarize the massive item analysis data derived from group testing.

Specific Examples

1. Examples of large districts reporting more trend data are:

Minneapolis, Minnesota

The Minneapolis Profiles of Performance annually report city-wide trends in Reading, Mathematics, and Student Attitudes Toward School, along with National Assessment Reading results, ACT scores, college achievement, and dropout status. Reports are published school by school and for the total system. Displayed in each building report and in the city-wide report are pupil, staff, and community factors, which include:

Enrollment
Percent of average daily attendance
Pupil mobility
Pupil/teacher ratio
Number of teachers with masters degree or equivalent
Percent of pupils eligible for free lunch aid
Performance on achievement tests, stated in terms of local norms only

No correlations of the factors are calculated nor is any interpretation of their interaction made. No comparison with national norms is made on building test data, only on district-wide report. A sample high school profile is attached at the end of this article as Exhibit 1.

Columbus, Ohio

Columbus, in its annual publication, Progress in Education: A Report to the Community, reports the percent of students scoring at or above grade level (on national norms) for each of the past five years. In addition, each school building report comprises both a Principal's narrative summary of the year's highlights coupled with a statistical summary (Exhibit 2) including:

Staff data
Pupil data, including ADC data
Mobility rate
Library data
Test performance data for 2 years

Columbus also submitted a reading test report which provides student correct/incorrect response information, raw score, grade equivalent, class average, and a table showing the number of students scoring at various levels above and below grade level. (See Exhibit 3)

Pittsburgh, Pennsylvania

Pittsburgh reports Reading and Math scores by school in terms of the percent of students scoring in each stanine. (Exhibit 4) Four-year test results are reported for the district. The Pittsburgh "annual report" also contains a good discussion of the variables related to achievement, based on a recent regression analysis study. The variables listed are:

School learning ability (IQ) test scores
Socio-economic factors
a. Family income
b. Father's presence in the home
c. Family size
d. Family mobility
Racial composition of the school
School attendance
Number of first year teachers
Discipline
a. Teacher assaults
b. Vandalism

However, no data on these factors are reported either for individual schools or the district.

Other Examples

Austin, Texas, (see Exhibit 5) reports interquartile range comparisons for previous years and other related data on total

enrollment:

- Percent attendance
- Economic index
- Ethnic distribution
- Major special programs

Tacoma, Washington, reports 2-year comparisons of the percent of students scoring at various levels above and below grade level according to national norms. (Exhibit 6)

Jefferson County, Colorado, reports growth scores for two year periods between pre- and post-testing, summarized by school, area, and district. Individual student profiles report three years of test scores. (No samples submitted)

A southern district that asked not to be identified reports growth averages from one May to the next by matching only those students who took the tests both times. (See Fictitious Elementary School, Exhibit 7.)

Another southern city uses growth scales in addition to numerous other factors. (Exhibit 8)

2. Examples of criterion/objective referenced test reporting systems include:

Portland, Oregon

For locally-developed tests in Reading and Mathematics, Portland includes in its system a computer-generated report (by school) of actual and predicted achievement data, based on Socio-Economic Status prediction formulas and Rasch standard scores. (Exhibit 9) In addition, individual school reports show goal attainment for a school, its geographic area, and the district as a whole.

Philadelphia, Pennsylvania

SCORITEN, a program written and developed within the Philadelphia School District Office of Research and Evaluation, can be used with any teacher-made test up to 75 items. The classroom report shows the teacher at a glance which items are giving trouble to the class as a whole and which subtests have been mastered and not mastered by each student. Reports may also include complete grade, whole school, and total district results on the particular test. (See Exhibit 10 for a sample output of a locally-developed criterion referenced phonics inventory.)

Oakland, Michigan

Oakland Schools in Pontiac, Michigan, have developed a complete computerized management system that includes several

test reporting and achievement monitoring systems. One system --PORT (Prescriptive Objective Referenced Testing), provides two types of reports: (See Exhibit 11) (1) a two-way tabulation of pupil achievement on each objective and the percent of the class meeting the criterion on each objective, and (2) a listing of the objectives by name, and the number and percent of students meeting the criterion.

3. The third area where test directors and computer directors seem to be attempting to help teachers and administrators wade through the massive scoring data pertains to item analysis information:

Detroit, Michigan

Detroit takes the skills classifications designated by the test developer and reports the number of students choosing each answer choice, compares the percent correct with the national norm group percent correct (p-value), and provides an average difference from local to national for all the items in the total skills classification. (Exhibit 12)

Milwaukee, Wisconsin

Milwaukee reports deviation from norm for each item and also for the total test and skill categories and then graphs the deviations on a bar graph. (Exhibit 13)

Nacomb, Michigan

Nacomb Intermediate School District in Mt. Clemens, Michigan, has developed a unique item analysis system to assist school personnel in analysis and interpretation of group test results. The system, which they call Proficiency Based Analysis System (PBAS), has been designed to provide diagnostic evaluations for classroom teachers, curriculum personnel, and administrators. PBAS can be used with both standardized tests and criterion/objective referenced tests.

Two reports are generated by PBAS: The Quartile Report - Report Q - is designed as a detailed analysis for curriculum specialists and school administrators. The Graphic Report - Report G - is a less complex analysis of skill clusters that make up a subject area. Appendix A reproduces the section from Nacomb's Test Scoring Service Catalog that describes the PBAS reports in detail.

Nassau County, New York

The Nassau Board of Cooperative Educational Services has developed its Continuous Trend Testing System which

provides reports of objective attainment by means of the following level reports:

- Student Report
- Teacher Report, by objective
- Content Summary Report for teacher
- Content Summary Report for Principal

Exhibit 14 shows a sample Teacher Report.

Montgomery County, Maryland

Montgomery County has developed several reports for its criterion-referenced tests keyed to pre-algebra mathematics objectives. The 248 key objectives are divided into 26 categories. The reports include:

1. A Class Profile by Category
2. Individual Student Profiles
3. A Monthly Assessment Report, by class, that lists which categories were tested, which students were not assessed in any category, and information on problem solving abilities. (No report samples submitted.)

There are other interesting reports submitted in response to the survey which do not fit the foregoing three categories.

Broward County, Florida, develops a complete Diagnostic Report for Teachers with a Diagnostic Card output to students. (No sample submitted.)

Atlanta, Georgia, has adopted the use of the Age Achievement Quotient (AAQ) "to provide a more appropriate test statistic for ungraded schools." The AAQ is derived from Age Equivalent norms provided by the developer of the tests that Atlanta uses. (No sample report submitted.)

New York City, because of its high mobility rate, has developed a unique system of student identification numbers to facilitate keeping track of students from grade to grade and school to school.

Finally, another district which asked not to be identified has developed a data bank of all test results on all students from which several unique reports can be generated:

1. Student Test Record Profile -- a student's historical record of all test results on file, by test type (e.g., ability, reading, etc.), showing test name, norms used, when and where test was given, raw score, percentile, stanine, and stanine graph.

2. Test Record List -- a listing of test results for all students in a group (e.g., grade), showing each student's past record of test percentiles and stanines plus the most recent stanines in Reading, Writing, English, and Math. The last page of the Test Record List presents a table of the number of students scoring

at each stanine, based on most recent score available in each of the four curriculum areas.

This is not a complete list of all the systems and reports that were submitted to answer the survey, but in the opinion of the reviewer they represent the most unique and innovative. The survey in no way purports to be scientifically collected or analyzed, but it probably is a good indication of the activity taking place in developing useful reporting systems. The survey purposely did not include test publishers because their catalogs with samples of new reporting services are readily available.

Other Questions

The other questions in the survey pertained to the test used and the biggest unsolved need.

In addition to locally developed criterion-referenced tests, the tests used were about equally dispersed among the widely known standardized tests:

- Comprehensive Tests of Basic Skills
- Stanford Achievement Tests
- Iowa Tests of Basic Skills
- Metropolitan Achievement Tests

The answers to the question on the biggest unsolved need in test score reporting provided the most surprising portion of the survey. 42% of the responses to this item revolved around the lack of knowledgeable and effective use of test results. The situation seems to be that students, teachers, parents, etc., are not able to derive meaningful interpretations out of the array of numbers offered them -- numbers apparently with meaning only to statisticians and psychologists.

Yet little of new interest is being developed in the area of student reports. Student scores are still generally reported as they were 20 years ago in lists of grade equivalents with graphs of percentiles or stanines. A gummed label of the same scores is provided for student reports and/or cumulative records.

Varying degrees of definition of terms and "How to Interpret..." suggestions are offered. These are usually of the same general nature as those furnished by the test developer, if not the actual publication of the developer. Thus, the obvious need (at least to this reviewer) in test result reporting is help in interpretation.

Can Computer Help?

The computer has made it possible to grind out pages and pages of statistical lists, distributions, and analyses. Perhaps the computer can now be used to

help synthesize, simplify, and explain these results. If astute educational data systems analysts convened a group of teachers known for making good use of test results, they could observe and possibly chart the teachers' decision processes and develop an acceptable algorithm for test score interpretation. A tiny step toward greater, and possibly better, utilization of test results might result.

Instead of further computer analysis, let's work for greater computer synthesis of test results.

Conclusion

From the results of this informal survey on innovations in test score reporting, it is apparent that large school districts are trying to provide more meaningful test score interpretation help to their public. Not very much new activity is taking place in helping individual students interpret the results of tests they have taken. Nor are breakthroughs apparent in helping teachers make better use of test results in day-to-day curriculum decisions.

As a final note, this reviewer wishes to thank the many test and DP directors who spent considerable time answering the questionnaire that served as the basis of this article. The opinions expressed are the author's alone -- not his employer's nor any of the survey responders'.

Examples of the reports referred to in the text will be provided by the author at the time of presentation.

INSTRUCTIONAL FLEXIBILITY IN CATEGORICAL PROGRAMS THROUGH ELECTRONIC DATA PROCESSING

Edgar N. Morgan, Texas Education Agency,
Walter Block, Joe Brown, and Janice Casillas, San Felipe-Del Rio CISD

Guidelines for categorical programs encourage schools to arrange instructional activities to maximize the resources to meet identified learning needs. However, assuring that each fund is spent only on eligible pupils for particular activities often becomes so difficult that schools must sacrifice effective instructional arrangements for those which make the fiscal accounting possible. This paper describes a program in which each pupil's eligibilities are coded, and a computer is used to prorate the expense of each classroom among up to eleven categorical programs based on class membership.

Ideally, the learning experiences of any pupil should be tailored to his/her individual needs, capabilities, and aspirations. In the 1960s it had become painfully obvious that this was not being done--that large numbers of children were hindered from realizing their full potential by societal and environmental forces beyond their control or their parents' control. This situation, which is still with us today, along with our traditional egalitarianism and sympathy for the underdog, engendered scores of federal programs, each aimed at upgrading the education of a particular group of children. Noble sentiments motivated these programs, and to a certain degree, the approach to providing the needed services is quite practical. In general, the approach is one of advocacy. There is an advocacy/funding mechanism for virtually all identifiable groups of children who are seen as being disadvantaged for some reason associated with their membership in the group. The comprehensive range of the groups assures that very few children with educational needs will be without advocacy. If one thinks of an educational needs remediation system in three dimensions, as shown in Figure 1, then each child eligible for special funding falls into some group which has an advocacy and funding mechanism.

Typically, categorical program guidelines suggest that the needs of the children within the advocacy group be assessed and the appropriate instructional treatment be prescribed for their needs. This diagnosis and prescription would produce a two-dimensional, need-by-treatment matrix like the top slice of Figure 1. For example, a migrant child is diagnosed as having a problem in mathematics which can

be best alleviated in a laboratory situation. Other migrant children may have the same problem, but their individual characteristics call for other instructional arrangements. The same situation holds for language arts, social studies, and affective development. Different children require different kinds of instruction within the same general subject area if they are to catch up to their peers. While matching treatment or instructional arrangement with pupil needs and characteristics is sound educational theory, it is rather difficult in practice, requiring as it does, several alternative approaches to the same subject area. As difficult as it

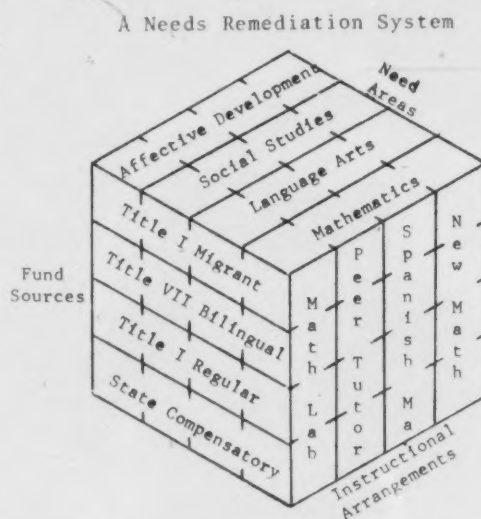


Figure 1

is to match treatment with need, the delivery of the appropriate instruction is further complicated by the arbitrary (from an instructional point of view) classification of pupils by funding source. The advantage of the advocacy approach lies in its power to see that few children are left out of the remediation process. But it sometimes impedes the process itself. Categorical guidelines jealously guard program funding to see that all the money prescribed for a population category is spent on pupils who belong to that category.

If the advocacy/funding groups coincided with the groups formed on the basis of needs of the individual pupils, then one could simply assume, for instance, that all migrants have the same need. Then one would specify several alternative treatments and choose the best alternative for each child. All the alternatives implemented to meet that need would constitute the migrant program. On the other hand, if a particular kind of instructional arrangement were proven to be always the most effective method of teaching the children from a given funding category, then the problem would also be fairly simple. A migrant child who had any kind of reading problem would automatically be placed in the migrant reading program, the single instructional approach proven best for all migrant children.

While not too many people actually believe that all migrants or any other group of disadvantaged children respond best to the same treatment, many educators are virtually forced to act as if they believed this to be the case. For the sake of survival they treat the category-by-need-by-treatment matrix (Figure 1) as if it had only two dimensions. Schools have found it an overwhelming task to fund each pupil only from the eligible source(s) and, at the same time, provide each with the appropriate need-by-treatment match. There are two reasonably straightforward solutions to the problem, but both are rather complex in practice.

The first solution is obvious from inspection of the matrix, but it is just as obviously impractical. The school simply establishes a class for each cell of the matrix and places every child in every funding category in the class which matches both his need and his most effective learning situation. In this example there are four categories of pupils, four need areas, and four arrangements for meeting each need. The pupils might be funded from Title I Regular, Title I Migrant, Title VII, or State Compensatory funds. They could have learning needs in either mathematics, language arts, social studies, or in their affective development. If their needs lay in the area of mathematics, their individual

characteristics might indicate that they should be placed in either a mathematics laboratory, a peer tutor program, a math in Spanish class, or a new-math approach. Other need areas would also have alternative instructional arrangements appropriate to the subject and pupil characteristics. These combinations add up to sixty-four classes. If there were 1600 children whose three-way classifications fit them twenty-five to a class throughout the matrix in Figure 1, this would be an elegant solution. ($64 \times 25 = 1600$) However, it is possible that there could be as few as sixty-four pupils in the school, and they could still need all sixty-four classes to get the perfect three-way match. Obviously, the chances of getting a good matchup that also provides a reasonable pupil to teacher ratio are pretty slim with this solution.

The other solution is less obvious, because the regulations for funding tend to obscure it. In this method the matrix is reduced to two dimensions by temporarily ignoring the funding dimension. First, all the children are considered, and the best feasible match between individual needs and treatments are obtained. Of course, there can practically be only as many classes as the total number of pupils will justify, and the needs and most desirable type of instruction for each need will not be evenly distributed. Therefore, some compromise will probably have to be made. For example, more than one approach might be used in the same class, or some children might have to be taught by the second-best approach. However, temporarily ignoring the funding dimension has reduced the number of pupils necessary for a perfect need-by-treatment match from 1600 to 400, increasing the chances for a reasonable compromise by a factor of four.

Once the best compromise between the ideal and the possible has been made along the need and treatment dimensions, the other dimension--the funding categories--must be dealt with. This is accomplished by prorating the expense assigned to each need-based class according to its categorical constituency. A fifteen-member class, for instance, might be made up of six bilingual pupils, six migrants, two eligible for Title I funds, and one eligible for state compensatory funds, all of whom were placed in this class because it was the best possible instructional arrangement for their individual needs. To stay within the categorical guidelines, each major item of expense, for example the teacher's salary would be paid as follows: Forty per cent (6/15) from migrant funds, forty per cent (6/15) from Title VII funds, thirteen per cent (2/15) Title I funds, and seven per cent (1/15) state compensatory funds.

In the prorating solution, the categorical guidelines for funding only eligible

students are satisfied without disturbing the process of matching as nearly as possible the individual student needs with the most appropriate instructional arrangements. However, there is usually a rather sticky obstacle to implementing such a solution. The bookkeeping required to establish and maintain the categorical constituency of each class is beyond the means of school districts with any significant variety on their categorical programs. Imagine, the situation where a teacher with an aide who teaches five classes a day, each composed of anywhere from eight to fifteen pupils, each of whom is eligible for funding by up to eleven separate categorical sources. To prorate the expenses for that teacher and aide, two things must be done. First, the eligibility status of all pupils must be kept current. Second, the per cent of funding to be allocated from each category must be computed each month. The number of days in membership for each child must be summed, the total aggregated by category, and converted to per cent of the total instructional time. As unfeasible a task as this might be if handled manually, it can be managed quite efficiently using electronic data processing (EDP). The rest of this paper is devoted to describing how this has been done in the San Felipe-Del Rio (Texas) Consolidated Independent School District (SFDR) in the hope that it may stimulate other districts to investigate the possibilities of this EDP application for improving instruction.

SFDR has as great a diversity of specially funded programs as any school district in the nation for its size, roughly 10,000 pupils. In dealing with the problem described above, they administer funds from eleven sources, a task which motivated them to devise a specific, feasible prorating solution. Participation in several projects, notably Project Developmental Continuity, led the instructional leaders of the district to consider the possibilities of fusing the efforts of the separate, fragmented special programs in the district into coordinated multi-funded supplementary instructional units based on the needs of individual pupils. Using a ratio of 200 pupils to one teacher and one half aide, with each pupil attending the supplementary class one hour per day, the units are organized with a minimum of four teachers, two aides, and 800 pupils, each two or more grade levels behind in priority learning areas. Bringing that many professionals together allows for a team approach to assessment, planning, and instruction for the individual pupils. Having conceptualized their instructional approach, the school began negotiations with Texas Education Agency (TEA) officials to work out specifications of a system which would allow administration of the need based units while meeting

funding regulations. The complexity of the solution required the interaction and understanding of a wide range of participants at both the state and local levels. The district sent the superintendent, deputy superintendent, director of finance, director of instruction, accounting administrator, data processing administrator, payroll administrator, special programs accounting assistant, and the directors of all special programs. TEA sent the director of federal funding, the director of migrant education, a consultant in consolidated program application, a chief accountant, and supervising auditor. The Education Service Center (ESC), Region 20, sent a consultant in migrant education, since the outcome would have implications for many districts in that region. This long list of persons is included to emphasize the importance of early involvement of everyone whose cooperation and assistance will be needed in working out the details of prorating a multi-funded program. The negotiation resulted in tentative approval to proceed, contingent on the district's establishment of a system for (1) determining the eligibility status of each student for each special program in the district, (2) reporting participation of each student in instructional activities funded in whole or in part by the various special programs, (3) payment of salaries of personnel providing instructional services to these pupils from a payroll fund on the basis of the salary earned; and (4) transfer of funds from the various special programs and/or foundation or local funds on the basis of the percentage of participation by eligible pupils during the period of salary earning.

Several interrelated obstacles prevented the district from using the EDP facilities of an ESC at that time, so they initiated the program purchasing time on an NCR 500 owned by the City of Del Rio. Therefore, the procedures described were actually used for a card-based system, although SFDR is currently converting to a disc based system, leasing time for a local accounting firm's NCR 8200. The elements on which the procedure operates are punched into two cards as follows:

Card 1

Columns 1 - 2: Type of transaction.
Columns 3 - 11: Student ID number.
Columns 12 - 35: Parent's name.
Columns 36 - 80: Complete address.

Card 2

Columns 1 - 2: Type of transaction.
Columns 3 - 11: Student ID number.
Columns 12 - 35: Parent's name.
Columns 36 - 46: Telephone number.
Columns 47 - 51: Bus route data.
Columns 52 - 53: Sex and race.
Columns 54 - 55: Grade.
Columns 56 - 61: Birthdate.
Columns 62 - 67: Date of entry.

Columns 67 - 80: Eligibility/participation in special programs.

For each of the programs, eligibility/participation is coded as follows:

- 1 = Eligibility either not determined or not required,
- 2 = Determined to be ineligible,
- 3 = Determined to be eligible, but not participating,
- 4 = Determined to be eligible and is participating, and
- 5 = Eligible, participating, and being funded from this source.

The special programs for which eligibility and participation data is recorded are: National School Lunch Program, ESEA Title I Regular, ESEA Title I Migrant, ESEA Title VII, State Bilingual, State Compensatory, ESAA Pilot, ESAA Bilingual, ESAA Regular, Headstart, Project Developmental Continuity, and Special Education. After conversion to the NCR 8200 operation, the limitations of the 80 column cards will no longer restrict the coding and additional information such as type of instructional unit, test scores, and other performance data may be added.

Using a small grant from ESEA Title IV, Part C, the district hired a data clerk to gather the initial data for the approximately 10,000 public and non-public school pupils in the district during the summer of 1976. With the initial file in machine readable form the following operations (Figure 2) are performed in order to meet the funding conditions specified earlier.

1. On a daily basis all enrollments, with drawals, and changes in eligibility status are reported to the data clerk who continuously updates the eligibility report, a printout listing the contents of the two student data file cards for each pupil in the district.
2. The keypunch operator updates and verifies the changes specified by the data clerk.
3. On a monthly basis a student count worksheet is printed by listing the contents of all cards punched 5 (eligible participating, and drawing funds) for each compensatory program. For each fund the printout shows totals for each grade by campus, each grade across campuses, and all grades, all campuses.
4. The student count worksheet totals for each grade at each campus for each fund and the grade/campus total across all funds are keypunched into student count cards.
5. The numbers of pupils on the pupil count cards are converted to percentages, printed on a student percent report and punched into student percent cards.
6. The student percent cards are merged with fund cards from the payroll system and processed to punch the compensatory fund cards containing the amounts earned, paid, and reserved for each teacher from each fund.
7. The compensatory fund cards are

processed to punch cards in a format acceptable to the accounting system where they will cause subtracting payroll expenditures from the appropriate compensatory funds and give an updated balance for each fund.

8. The compensatory fund cards are next processed to produce the compensatory personnel report and the compensatory fund report by organization. The compensatory personnel report lists amounts earned, paid, and reserved from each fund for each teacher in order of teacher number. Totals of all earned, paid and reserved amounts for each fund and for all compensatory funds is also shown.

9. Next the compensatory fund cards are merged with master cards from the payroll system and the payroll information report is printed showing the cumulative totals from each payroll account.

The output of these operations regularly supply the reports and audit trails required by the funding sources. SFDR has reported other benefits accruing from the program such as compliance with a sudden request for a supplemental state bilingual list in a fraction of the time such a compilation would normally take, and it has served to keep track of the two classifications of migrant pupils which surfaced recently. However, the main benefit is the one for which the program is designed--to free SFDR educators to match individual students with the most effective instructional arrangements for meeting their particular needs--the first step toward true compensatory education.

The Student Data File in Operation

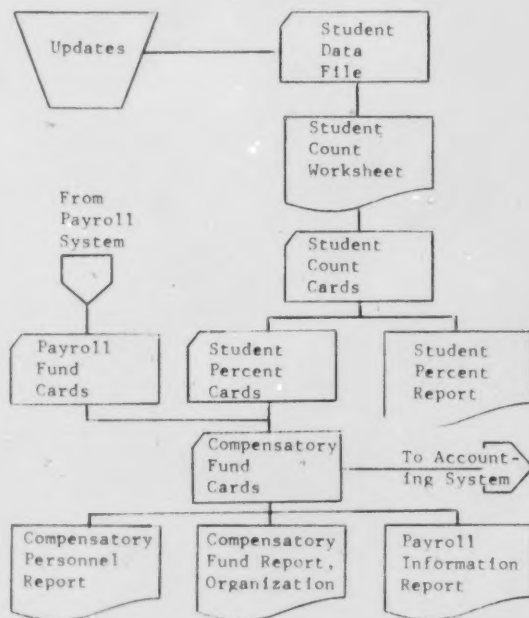


Figure 2

PRIVACY AND COMPUTERIZED
STUDENT RECORDS:
COMPLEXITY, COMPREHENSION
AND COMPLIANCE

Dr. D. Thomas King
St. Paul Public Schools

Abstract: In 1973, the federal government enacted the so-called privacy or "sunshine laws". To protect students, parents and school people, the law has 1. defined student records, 2. indicated procedures for inspection and release of records, and 3. provided for the right to contest or challenge the accuracy or completeness of records. School administrators have had to: 1. establish or modify records policies and procedures, 2. develop new written guidelines and forms, 3. inform and train involved personnel, 4. notify parents and students of their privacy rights, 5. equally as important, make this new system workable. This paper examines some of the problems in complying with the law: both in establishing and modifying administrative and computerized data procedures.

Background

One is reminded of a paraphrased quote from Lewis Carroll's *Alice in Wonderland* in reflecting on a basic potential weakness of all data, records and information:

"But what does it mean?" asked Alice.

"Why it means precisely what I want it to mean, nothing more, nothing less!" said the Queen.

It is not the purpose of this discussion to consider this fundamental and philosophical epistemological problem. Rather our purpose is one which should be considered by all those who collect and use information: What meaning should be assigned to data which is collected, massaged, summarized and reported? Any information-gathering school district or agency must think through such questions and establish written guidelines which are understood and practiced as consistently as possible in dealing with the public served. In fact, the following statement establishes the theme of this discussion: we school administrators must make certain that clear guidelines about information procedures are developed and clearly set in writing. If this dictum is followed, one finds fewer "Alice-like" questions and even fewer "Queen-like", nonsense responses.

The Federal Privacy Law

In 1973, the Family Education Rights and Privacy Act (FERPA) was signed into law establishing the rights of parents and students to: (1) know what information was being collected by the schools, (2) specify who, other than parents and appropriate school personnel, might have access to records, and (3) challenge, through a formal hearing if necessary, the accuracy or completeness of a given record. This law was landmark legislation, and not unexpected by many sensitive to Washington "wind". Government and the courts have been deciding, to an increasing extent in the past decade, how schools shall be operated, financed, and function in many critical areas formerly left to the discretion of local school administrators and state and local school boards. The courts generally had established school people as acting in loco parentis, (literally, in the place of parents) as we discharged our functions in educating young people. We attempted to act, or should have, in the "best interest" of the student and his family. Hence, our guideline always had been: Is this educational program, policy or practice clearly in the best interest of the student as an individual, and society as a whole? This was an extremely difficult, possibly conflicting, guideline at best. Now under the new law(s), we must attempt to balance the need of schools to have relevant information with the parent's or student's right to privacy. Unless a district had clear, consistent, comprehensive guidelines in

the past (and most didn't), school people simply made the "best" decision possible in each circumstance. Now there are regulations. However lamentable such long-distance regulations (and local control erosions) from our federal government may be viewed; nonetheless, they are law.

Whatever one's predilections, it is submitted that privacy legislation was needed. With its recent amendments (1974), FERPA is comprehensive, clear, commonsense and compliant. Many can argue with all or part of the above statement, but in discussing such matters with colleagues (including school people as well as non-educators), one finds a high degree of consensus about the workability of the new laws. Why? The laws have forced all of us (1) to look more carefully at what "needed" information we collect and the purposes served, (2) to examine next what are the associated costs as well as the benefits of such information and (3) to involve and educate the public we serve concerning these records and purposes. So the intent and results of these laws is "sunshine" (as they are often labelled). In addition to the smiles and happiness one often associates with sunshine and light, occasionally one finds frowns and befuddlement. Many ask: (1) what is needed (2) what are the costs (3) how is the public to be informed? This article delineates some of the problems which may be encountered in answering such questions and attempts to point out related critical and sensitive areas of concern.

Complying with the Privacy Laws

Reference is made here, occasionally, to privacy laws. Such is the case because, here in Minnesota, for example, (as in over 25 other states) there is also a state law on privacy. To compound the problem, this state's law affects not only schools, but all government agencies, municipalities and related units of government. Because of the broader legal scope and differing audiences, some serious, local problems of interpretation and compliance have arisen. At this point in time, the state Data Privacy Commission and the legislature have been unable to give a definition of public, private and confidential records. Hence, in Minnesota, currently, all records are public! (But only technically, of course!) The federal law not only has the definitions down, it has the penalties for non-compliance specified. They hit a district where it hurts most: dollars. The act provides for the withdrawal of federal funds if any school district fails to comply. "Comply" means the district must grant parental right to review and

inspect all school records and to have a copy of such records. This district defines "educational records" as those which refer directly to the student.

We maintain these records do not include: (1) a teacher's personal notes about a student which are kept in the sole possession of the maker and not revealed to others, (2) records of any law enforcement unit attached to the district and (3) medical, psychiatric or psychological data used in the treatment of a given student. Even with such precisely-worded definitions, however, exceptions and exclusions may occur in some instances, particularly if another law impinges:

- (1) Under Minnesota law, any student of any age has the right to access his records.
- (2) Under Minnesota law, notes which are exempted by federal statute (perhaps comments as well) may have to be made accessible.
- (3) By federal statute, a parent may choose a physician to review exempted medical and psychiatric data.
- (4) By federal statute, counselor and social worker records might not be considered exempt.

Ultimately these conflicts and problems will be resolved. At present we work with, through and around the ambiguities.

Historically, no legal expression of the so-called right-to-privacy occurred until the turn of this century. Such rights clearly were recognized in the federal constitution and earlier in English common law. Indeed, the Supreme Court has recognized this right as protected by the Constitution and among "the most comprehensive of rights: the right most valued by civilized men".

The Michigan Law Review (73:1303 - 40, May-June, 1975) has set down guidelines for collection and use of data. The Review states consideration must be given to: (1) the sensitivity of the information sought, (2) the importance of the purpose for which relevant information is sought, (3) the form in which the data is stored, (4) the length of retention and breadth of dissemination. Once these considerations are understood, it is incumbent upon a school district to comply with it in the manner most legally and economically suitable.

Compliance in District 625 (St. Paul, Minnesota)

Prior to the enactment of the privacy legislation, the St. Paul Schools had the good fortune to have had an ad hoc committee with the primary charge of examining and revising student records and procedures. The committee hoped to find more effective and less costly ways of dealing with the wealth of data being collected (and the frequent dearth of meaning associated with it). The committee had district-wide representation: principals, counselors, teachers, social workers, psychologists, nurses, and other district administrators representing special education, transportation, federal programs. Nearly every relevant major program area one finds in a relatively large city school system was represented. So when the privacy push was becoming law, this district had a working group to study the pending legislation, examine current records and practices, and make the necessary recommendations to the superintendent's cabinet and the school board for action and approval. It was refreshing, for a change, to be acting instead of reacting. The cost to the district to comply was minimal: the cost of forms.

First, what data did the committee believe was essential to collect? Listed below are the various records:

RECORD	COMPU- TER	MAN- UAL
Census Information	X	
Attendance Data	X	
Class Scheduling	X	
Test Records		
a) standardized	X	X
b) individual psy- chologicals		X
Health Record		X
Grades (Report Cards)	X	
Related Achievement Data (class rank, GPA, etc.)	X	
Teachers Observa- tional Report (elementary, junior high)		X
Student Information Sheet (senior high)		X
Permanent Microfilm Record (Academic and Health)	X	X

A number of former "records" were abolished at this time. Some school administrators, perhaps in great fear of lawsuit, burned or destroyed everything of a questionable nature. The general approach was to destroy all unofficial notes and records, all subjective records which appeared to be hearsay and unsubstantiated, all records which were more damaging than

diagnostic, more harmful than helpful. Of course some valuable records were destroyed in the name of new found zeal and enlightenment. But many school administrators were confused by the law. There is no penalty for having sensitive, subjective information in a student file. FERPA only provided access to such records and the right to challenge them. Laws against malicious statements in writing (libel) or utterance (slander) have existed for years. The best defense against libel and slander is to show the statement, however malicious, is true. If it is, there is no libel or slander. The import for school records was not "truth", however. We hoped to believe school records were true (when, in fact, we knew some were not). The import has been to make records which can be substantiated, if records are to be made at all. Some examples of a questionable nature are:

"Johnny is retarded," instead of "He scored at the 10%ile on an intelligence test."

"Johnny is a thief," instead of "He was observed taking money from a desk drawer."

One could argue, and successfully I think whether such comments belong in a student's record at all. If judgmental information must be included, it ought to be substantiated (and essential for optimizing instructional services)!

Decisions about psychological, social work and health records were left in the hands of the respective professionals. However, both psychological test data and social worker case records now are destroyed within five years after the student has left the school system. No longer are these records microfilmed for the permanent record file. The health record and a summary of the academic record: courses, grades, standardized test results, rank in class still are filmed here and kept along with over half a million other permanent records going back into the late 1800s. But now by law, the parent or adult student has the right to inspect such records and dictate to whom they are to be released.

Also a part of the "permanent" record system is the traditional school census list. It is important as a public document and also as a basis for state aids. Names and related directory information on all students who are residents of our district each year are kept for census purposes. Since St. Paul has a relatively large non-public

school population (15,000) students, the total number of such records last year was 55,000, declining from a high of 70,000 records in 1971. Imagine, if you will, typing the register sheets for such a census listing. That is what was done in 1969, the year before the census was computerized. At about 20 lines to the page, an "army" (15 actually) of typists had 3500 sheets to type. These backbreaking compendia gathered dust in a back room of our old administrative headquarters. I have a smaller one on my office credenza dated 1867, but hand-written of course.

No one listed among the over 4000 students in school at the time is alive today--so there is no privacy problem for that book. As I recall the census-taker was paid something close to a hundred dollars for his task. Our costs are in the hundreds of thousands today.

So also has changed the way we maintain these records. In 1970 we microfilmed those old tomes; later from 1971-74 we microfilmed the computer-printed sheets--no more typing at last. In 1974, the miracle of computer-output microfilm (COM) was gifted upon us. No more paper! Computer tape and a sophisticated computer-directed camera took pictures of images written on a video tube. A film cassette contains the equivalent of a two foot stack of computer paper. The advantage: less space, easily copied! The disadvantage: how do you make changes on or attach notes to film in a cartridge? We maintain a separate card file.

Current year student records now are available on Cathode Ray Tube (CRT) terminals in the Student Records Department. Inquiry and maintenance are far simpler, cheaper. No filing errors and filing costs, no expensive paper forms charges. The credibility gap has also been closed. When a question came in to us in the past as to the current status of a student record (especially important if the school is attempting to build a class schedule for the student by computer), it took 24-48 hours to get through the queue in data processing for a response or a change. We sure got a response from the building principals: "How can a machine that works in a fraction of a second take days to get an answer?" Now the records are retrievable on our scope in just a second or two: credibility. It is an important word if you want cooperation from school people and the public.

These new CRTs present a concern about who has access to what. Security levels are built into the inquiry and mainten-

ance programs. Unless you know (or can "crack," which is highly unlikely) the access code, the operator can't get at certain portions of student records. For example, ethnic code is protected to the highest level of security. Note how the security level functions. These messages are printed on the screen:

Program Name? _____
Security Level? _____
Alternate Programs? _____

If you can't respond properly, you are frustrated quickly: "Inoperative terminal." We have had no known detectable problem with security of records in this district. Parents are informed that school people who have a need for relevant student information may access such information unless the parent restricts it. Parents are informed of their rights in our brochure which is distributed upon registration.

Generally speaking, the greatest danger in using computerized systems for records is that to gain superhuman speed, accuracy, memory one must give up, to some extent, human control. Hence, we hear: "To err is human; to really foul things up requires a computer". Mistakes made in nanoseconds can mail a thousand free lunch tickets to the same address (too much of a "good" thing?). Thousand line per minute printers can be programmed to spit out reams of meaningless information. "Garbage in--garbage out." So, the key concern is constant attention to what we are trying to do and modification when such informational objectives aren't being reached or are changed.

In this district, few parents access records, even fewer parents restrict records. We have yet to observe any improper or illegal attempts to access records from the terminals. The author believes there is little motivation to resort to illegal access for school records in general. There are no secret formulas to crack, no inventions to pirate away, no dollar profit motive. Those other public agencies who now, like the proverbial spy, are left "out in the cold" when it comes to unauthorized records access, usually get the necessary release or get their information elsewhere. An unfortunate example follows:

For a year or so after the new law, our relations with the local police were a bit strained at best. Police officers could no longer come in to a school and access student records without a release. So then some building principals found some police a bit slow to respond to bomb scare calls, to altercations and other emergencies.

Those problems now have been largely resolved: police, probation officers, and other government officials get a signed release if they need the full student record. Relatedly, our district does have a policy of releasing "directory information" to the above agencies if no restriction has been placed on the record by the parent or adult student. Directory information is not given out to any party requesting it. Fortunately, there is some room left for prudent decision-making by so-called "highly-paid" school administrators trying to earn their money. Unrestricted directory information (consisting of name, address, birthdate, school, parent or guardian, phone) may be released in certain circumstances. Basically, the policy amounts to the administrator-in-charge deciding if the requesting party has a legitimate need to know and the release of said information is not contrary to the welfare of the individual. For example: (1) We do not release directory information to Alden's catalog mail order house in Chicago, attempting to track down those whose credit is in arrears. (2) We do not release directory information on 18 year olds to local politicians for mailing list and campaign purposes. (3) We do cooperate in releasing such information to such agencies as police, armed forces, Bureau of Health, Social Security, County Welfare if the need for such information is legitimate and releasing it is within the law.

To make the entire system work well, the forms developed must be few in number, clear and understood by those who use them. After a couple of years of trying them (or was it trying years with them), our forms now appear as described below.

1. Account of Information Released from School Records:

This form must be signed by any person who accesses the student record. The form is then kept on file alphabetically. School personnel sign the form only once in a given year.

2. Request to Collect Special Data Regarding Your Child:

This form is used to gain parental consent for any special testing--particularly individual or psychological tests. Our brochure states that standardized group tests are given without requiring special consent.

3. Request to Release School Record Information:

This form, signed by a parent or adult student, authorizes the release of various school records to a specified third party. Such authorization is not needed by school personnel as explained in our brochure.

4. Request for School Records:

This form is mailed to an other school district when a new student transfers into our schools. Although our district has a policy of releasing school information to a new school upon transfer, unless otherwise directed by the parent. This form is used with districts not having such a policy.

5. Restriction on Directory Release or Transfer of Student Information:

This form permits the parent to restrict in part or in full the release of directory information to third parties or the transfer of school records when a student transfers to another school district.

In the final analysis, a system will work well only if it is developed with a representative group of those involved, implemented to have the support of those involved, and continuously evaluated by those involved. Suggestions must be solicited; contacts must be maintained. We hold meetings each year in the fall and area meetings throughout the year. Bureaucratic systems are not only for people, they are people. If the human factor is left out, machines might as well perform the task. Such consignment of the human qualities of responsibility and judgment to machines or a department that functions like a machine is what motivated Orwell to write his horror story, 1984. Incidentally, we're only 7 years away from that date. I believe the new privacy legislation, the renewed interest in and concern for the privacy rights of people keep books like Orwell's sufficiently horrifying. It would be a true horror, rather than a fictional one, if conditions were such that abuse of such a fundamental right as privacy was commonplace. Those of us responsible, in whatever way, direct or supportive, for the education of young minds, therefore, have a serious responsibility. John Milton, the poet, although blinded, put the issue in clarity:

"Laws can discover sin, but not remove."

That alone is the function of man; to judge and to act wisely within the perimeters set by the collective justice of law and the individual ethics of conscience.

PREPARATION OF ANNUAL DATA ACQUISITION PLAN
FOR A STATE EDUCATION AGENCY

Jerry T. Barton
Texas Education Agency

Requests for data from state and federal levels levied upon school districts has increased steadily in recent years. Public school personnel are being inundated by information requests. In 1969, the Texas Education Agency established its Reports Management System (RMS) to control data requested from school districts. The product of the RMS is Bulletin #742, "School District Data Submission to the Texas Education Agency." This bulletin and its updates represents the state and federal report requirements levied on districts. The bulletin and its updates in effect become the annual data acquisition plan for the Texas Education Agency.

Overview

Requests for data from state and federal levels levied upon school districts has increased steadily through the years. Public school personnel are being inundated by information requests. However, state level staff time and effort has been dedicated to the task of coordinating report requirements that are levied on school districts. The Texas Education Agency established the Reports Management System in October of 1969 to address this problem. Since 1969 all reports, applications, and evaluations, must be reviewed and approved by the Reports Management System before being used for data collection from local school districts. The product of the Reports Management System is Bulletin 742, and its annual updates and additions, plus the federal requirements to the bulletin constitute the Annual Data Acquisition Plan of the Texas Education Agency.

Efforts to improve data acquisition planning and coordination are also under way nationally. The Council of Chief State School Officers' Committee on Evaluation and Information Systems has been charged with coordinating this activity. The Council of Chief State School Officers policies on federal data acquisition 1) supports the concept that all such activities should be coordinated through the National Center for Educational Statistics of DHEW, 2) the right of each chief state school officer to exercise his option for data collection, 3) nine months lead time for data collection. The CEIS work is coordinated through a single CEIS state coordinator within each state with as many other state and local people as needed. Results of RMS and CEIS include the publication of Annual Data Acquisition

Plans that identify report requirements before the year starts, and reduction of the data burden at both the state and local levels. Also, a result of the coordination between the state and federal levels, numerous federal data requirements are completed at the state level and not passed on to school districts.

How the Annual Data Acquisition Plan is Prepared

In February of each year a schedule is prepared and coordinated through the Texas Education Agency planning mechanisms for approval of next years report requirements. This plan specifies that by April 15 all new and/or revised as well as on-going report requirements will have been studied and approved. The approval process includes these steps in sequence:

1. RMS staff study and review
2. RMS Review Committee study and recommendation
3. Middle management (division directors) review and recommendation
4. Top management review and approval
5. Signature of the Commissioner then authorizes the data collection activity

See Exhibit #1 for more details.

Program managers requesting new or enlarged reporting requirements are required to complete a set of data specifications prior to beginning of the approval process. These specifications are intended to cause the program manager to consider all aspects of data collection, storage, and dissemination. They also include a Data Processing Plan which (if applicable) must be completed by the computer systems staff.

The federal aspect of the Annual Data Acquisition Plan is pursued as part of the activities of the Council of Chief State School Officers' Committee on Evaluation and Information Systems (CEIS). This group works with the federal program people to insure a coordinated and justified data plan for the federal level. Much effort is spent to minimize the duplication between the state and federal report requirements levied on districts. Also, wherever possible, federal reports are completed at the state level from data already collected from the districts.

By the time the Texas Education Agency Annual Data Acquisition Plan is completed, the state and federal report requirements are combined into a single reports calendar and is published as an update to that section of our Bulletin 742.

How the Plan is Disseminated

After both state and federal report requirements have been identified to the extent possible, Bulletin 742 is updated. Specifically, a Calendar of Reports (Part II) will be printed in the Bulletin format. Also, copies of all major report formats will be printed in 742 format. It is anticipated that this preparation and printing of the updates will be completed by June 15. At that time, these updates are transmitted to the holders of the bulletin over the signature of the Commissioner. They then become a ready reference for district management for the report requirement for the succeeding year.

Additions to Plan

From time to time it becomes necessary to add additional reports to Annual Data Plans. Generally, the same process is followed for approval of additions as in the original plan. The process also provides for Emergency Approval (where justified) and Administrative Approval (for minor changes to existing reports).

Benefits from the Plan

Benefits from this Plan include:

- A. Reduction in district data burden by inspection of all needs, justifications, and cycles
- B. Broader use of data collected by state level users
- C. Multiple use of the data between state and federal levels

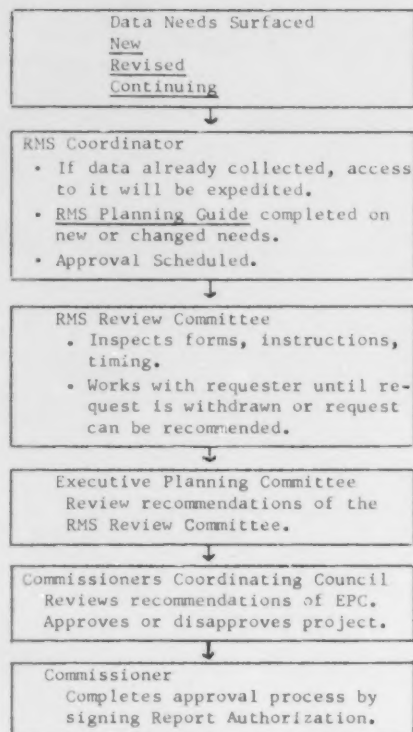
Increased Effectiveness

Increased effectiveness for the control of reports laid on school districts could be secured by 1) more publicity on RMS goals and accom-

plishments, 2) a more formal and systematic way for school districts to assist the Texas Education Agency to develop its Annual Data Plan, and additions, 3) development and implementation of a common core of data for state and federal program offices, and 4) enhanced systems and EDP capabilities.

Reports Management System (RMS) Preparation of Annual Data Acquisition Plan

Approval Process



Note: Regular Approval includes review and agreement by all levels indicated.

Emergency Approval includes review and agreement by RMS Review Committee and the Commissioner.

Administrative Approval includes review and agreement by RMS Review Committee of minor changes to existing reports.

EXHIBIT #1

SIMPLIFYING MASTER SCHEDULE CONSTRUCTION

James W. Nash
Wayne County Intermediate School District

ABSTRACT: An approach to master schedule construction that fits somewhere between a system that completely builds a school's master schedule and the traditional approach of supplying the school with a conflict matrix to help them build their own master schedule. Two procedures are used that analyze the conflict matrix data. One is used to build a model master schedule, and the other to analyze a master schedule which has already been constructed by the builder or by the school administrator. The scheduling administrator no longer needs to spend hours checking his master schedule against a conflict matrix, or totaling columns to achieve good balance. The analysis reports show how many conflicts will result and how class size balance will be effected by making changes to the master schedule.

Our approach has been to minimize the amount of effort required of the school administrator to construct his master schedule, and to achieve the best master schedule possible. We give the school administrator a choice between using a program which will build a model master schedule for him, or allowing him to build his own master schedule. We then use two reports which assist the administrator in analyzing his master schedule. One report indicates the best hours to offer a course for minimal conflicts, and the other indicates the best hours to offer a course for achieving balance between sections of the same course.

The master schedule builder uses a conflict matrix to determine the best time period for a section to be offered. A tally run is required prior to use of the builder, so that the administrator can determine the number of sections and the average number of requests per section. The user must supply the course number, the course name, the number of sections for each course, and the maximum seats available per section. The maximum seats available should be about 10% greater than the average number of requests. The seat size is used to balance the master schedule with an equal number of seats each time period. All full year courses must be specified as well as any courses where every section meets the same term (semester). If the term is not specified the builder will choose the best term for each section of the course. The administrator may also determine the hour when a course is to be offered or not offered.

The administrator can indicate if a course meets for more than one hour or term on those courses which are left up to the builder to assign. The administrator may further specify for those courses which have sections that are to be distributed to different terms that a certain number of sections be available for any particular term. In addition, the administrator may include department codes and request that courses in each department be evenly distributed to the various time periods available. A restriction code may also be used to prevent two different courses from being assigned in the same time period. This becomes necessary when there is only one teacher available, and you need to specify, for instance, that Spanish I and Spanish II can not be offered at the same time. You may also have room restrictions and wish to specify that Typing I and Typing II can not be offered the same time period.

The teachers and rooms are not included in the construction of the master schedule, and it is therefore obvious that the builder can not produce a final product. The builder is intended to provide a model master schedule which has minimized conflicts and achieved a good balance of sections each time period. The administrator will usually find that some courses have been given a time period which is unacceptable to him, and he will want to make adjustments before his final scheduling run. The administrator must

assign his teachers and rooms to the master schedule created and may need to make adjustments to the master schedule in the process. Again I emphasize that the builder is not intended to produce a master schedule that is usable without change, but a suggested model which has minimal conflicts and a good balance of courses. The analysis reports which are explained next should be used when making adjustments to this master schedule.

The master schedule builder will normally be used by a school which wants to build their master schedule from scratch, or is making major modifications to their program. Many schools will prefer to stay fairly close to a master schedule which has been developed in prior years. If this is the case, the builder is bypassed, and the administrator constructs his own master schedule based on the tally of requests. A conflict matrix is not necessary for this process. Only logic need be used in the placement of sections into particular time periods, and the administrator does not need to be concerned with their efficiency. Two master schedule analysis reports are run for use in making adjustments to the master schedule. If the master schedule builder was used, these reports will indicate the effects of making changes to the master schedule, and how much harm might be done. When a school constructs its own master schedule, the reports can be used to indicate how much improvement can be gained.

The conflict analysis report uses a conflict matrix of one- and two-section courses. These are the courses which will account for the vast majority of conflicts, so multi-section courses have been excluded from the report. The program compares each of the courses against all of the other courses in the matrix, and calculates the number of conflicts which would result for each hour and term based on the current placement of the courses in the master schedule. Thus the report might indicate that a one-section course which is currently being offered fourth hour has ten conflicts with all of the other courses which meet fourth hour. It will also indicate how many conflicts there would be if the course met sixth hour or any other hour. If sixth hour showed two conflicts, you can see that eight conflicts could be eliminated by moving this course from fourth to sixth hour. In like manner, you can see how many conflicts can be eliminated by moving any of the other courses. Or in the case of a school which has used the master schedule builder, how many additional conflicts may be created by making the move.

The figures on the report soon become

incorrect as courses are moved from one hour to another. Therefore, it becomes necessary to run a new report after several changes have been made to the master schedule. It only takes about a minute to print a new report, so a great deal can be accomplished in a short period of time. There is a total line on the report which indicates how much room there is for improvement. The administrator can continue to adjust his master schedule until he is satisfied with the number of conflicts or until he reaches perfection. This program effectively does what administrators have been doing for years, as they ran a finger across and down a conflict matrix counting the number of conflicts for a particular hour, and then checking another hour to see if it might be better. This program saves many hours of clerical work for the administrator by analyzing the conflict matrix for him for all time periods simultaneously.

The other analysis report is a master schedule balance report. This report will assist the administrator as he attempts to provide an equal number of seats for students each time period. As with the conflict report, this report can be used to make improvements (by a school which has built its own master schedule), or to determine if changes will be detrimental to the master schedule (by a school which has used the master schedule builder). This report is a master schedule in chart form, showing the hours of the day across the top of the report, and the teachers in alphabetical order down the page. The teacher's courses are shown in columns beneath the appropriate hours including planning periods. With each class is printed the average number of requests for that section, broken down by grade level. These request counts are totaled for each hour and term, and printed at the bottom of the report. The number of students in each grade is also printed on the report, so it is easy to determine if there are too many or too few sections available for a particular grade during any hour or term. If the total seats available a particular hour are greater than the number of students, those sections can not be filled. If the total seats are less than the number of students, those sections will become overloaded. The administrator attempts to avoid this situation by moving sections which will tend to bring the total seats closer to the number of students, thus assuring good balance when the schedule is run. This report may be rerun after several changes have been made to the master schedule. It only takes about a minute to run a new report which will recalculate the totals and save the time it would take to do

this manually. Usually multi-section courses are used when attempting to improve the balance of the master schedule. If it becomes necessary to change a one- or two-section course to improve balance, the administrator can refer back to his conflict analysis report to see if the change will affect conflicts. These two reports work well together and usually compliment each other as the administrator analyzes his master schedule and tries to perfect it. All of this analyzing and adjusting of the master schedule is usually done before the first scheduling run is made. Thus considerable computer time is saved because worthless runs against a bad master schedule are eliminated. The first scheduling run may find some problems which were overlooked while analyzing the master schedule, but it is seldom necessary to have more than one trial run to finalize the master schedule before producing student conflicts.

We have found many advantages to these procedures. The school administrators are relieved of much of the work that used to be required of them to construct their master schedules. They are given reports to assist them in making decisions, rather than making more work. Our data processing consultants have been able to save time and give more help to the school administrators who are more satisfied with the service they are receiving. Computer time and supplies have been reduced by these procedures, and better master schedules are being created to meet the needs of students.

INFORMATION SYSTEMS & APPLICATIONS

Post Secondary & Higher Education

A MEDIATED INTRODUCTORY COMPUTER
COURSE FOR HIGH SCHOOL STUDENTS

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In view of the tremendous growth of computer applications in modern society and the seeming lack of the secondary school to prepare students to function in such a setting, an effort was taken to produce a computer literary course for all students in a high-school. Various instructional materials were either acquired or adapted to form a highly mediated computer orientation course. Initial results indicate the basic goals of the course were met and continued development is underway.

THE PROBLEM

"After growing wildly for the past decade, computing is now approaching its infancy."¹ This statement, included in the report of the President's Commission on Computing, was made over ten years ago, and, though there has been continued growth at an even accelerated pace, this still appears to be an accurate statement. Even with the almost innumerable improvements in computer equipment, and the continued gains in languages and applications, it still appears that, compared to the future, computing has not yet emerged from its infant stage. And in the midst of all this growth, secondary school curricula related to computing remains for the most part untouched. Consequently, students are facing a future which will be heavily influenced by computing, with little or no knowledge with which either to apply the power of computing or to evaluate the use of computers and their resultant impact on society. Thus the problem is that the secondary school continues to produce computer illiterates who are forced to function in a society heavily impacted by the computer.

THE SOLUTION

As an initial step toward the solution of the problem of computer illiteracy, an introductory course was designed and

presented to over 900 students of one high school in Independent School District No. 196, Rosemount, Minnesota. This course has as its general goal the presentation of information to provide an awareness of computing, with subgoals related to computing equipment, computer operations, languages, applications, and vocational opportunities.

The design parameters of the course included the following:

1. The course was to function as a unit within the existing mathematics courses.
2. Within the course the students were to be provided hands-on experience in designing, flowcharting, coding, and executing computer programs.
3. Computing capability was to be provided via computer terminals linked to a remote computer system, or through the use of on-site microcomputers.
4. The majority of the course was to be mediated, thus reducing to a large degree the need for specialized teacher training.
5. Teachers were to be provided with specialized training via an in-service workshop which focussed on how to manage the course, rather than specifics of computing.

¹Report of the President's Science Advisory Committee, Computers in Higher Education, Washington, D.C., The White House, 1967

In addition to these parameters for the introductory course, use was to be made of the computing equipment in courses other than the mathematics classes. Such applications were to be in the use of simulation and problem solving in the subject matter areas of science, social science, and business education. Again, such material was to be designed to be operational with a minimum of computer-related know-on the part of the teacher.

THE DELIVERY SYSTEM

In order to deliver a quality program to a large number of students in a short period of time, the following system components were developed or acquired:

Software

"Making It Count", a series of twenty half-hour introductory lessons on computers and computer applications, using television as the principal instructional medium, produced by Boeing Computer Services, Inc.

Supplemental instructional materials including overhead transparencies, student handouts, and instructor guides, produced by Dr. Normal Bell, Michigan State University, East Lansing, Michigan.

Computer programs involving simulation and problem solving, acquired from T.I.E.S., (Total Information Educational Systems), St. Paul, Minnesota.

Hardware

Video tape equipment suitable for playback of Boeing video cassettes.

Computer terminals used for access to T.I.E.S. computer.

Instructional equipment including overhead projectors and latent image feedback materials.

The television course, "Making It Count", was designed and produced by Boeing Computer Services to introduce college-level learners to basic computer concepts. Major topics which the course considers are hardware, software, system operation, advanced computer systems, acquiring and using computers, and the impact of computing on society. Since this course, as stated, was developed for college-level learners, only specific segments were used in the high school introductory course. These segments were as follows: Introduction, Historical Development of Computers, Information Representation, Hardware and Software, An Introduction to Programming, Computer Operation Centers, and a Review. These concepts were presented to the students through television cassettes, each topic being covered in

approximately twenty-five minutes.

The supplemental instructional materials were developed to enable teachers to make effective use of the television materials without being forced to spend large amounts of time and effort in preparation. For this purpose certain supplemental materials were developed for each lesson selected for use with the high school students. These materials included overhead transparencies, student handouts, and instructor guides. The overhead transparencies and student handouts were designed to be used to introduce and review each lesson. Basic components of this visual and handout material included an overview, objectives, structured notes, and a content quiz. The overview was provided to answer the question, "What's this lesson all about?" The instructional objectives were used to answer for the student the question, "What will I be able to do if I master this lesson?" Both the overview and the objectives were used prior to the viewing of the video tape.

Following the video tape, the teacher, using the structured notes, reviewed the key concepts of the television presentation. This review was designed to take about fifteen to twenty minutes of teaching time. The teacher, at the overhead, reviewed the key concepts, either by presenting the material or by drawing it out of the students. The students used the structured notes to record the important concepts of the television presentation. Following the structured notes, the teacher then instructed the students to test their learning using the instructional quiz. These quizzes were designed to be content checks allowing the students to determine if the key concepts of the lesson were known. In order to further reduce the work of the teacher, these quizzes were designed to be used with the latent image immediate feedback system. In this operation the student would respond to the multiple choice question by marking with a special pen or an answer sheet which had a latent image developed by the special pen. In this operation, the student would find out immediately if the answer was correct. In the cases in which the first try was incorrect, the student was able to continue responding until the correct response was noted. Thus, the students were able to evaluate their own progress, always knowing what the correct answers were immediately upon completion of responding to the question.

The final component of the software for this course was provided through access to the T.I.E.S. system. In this situation certain simulations were selected for use by the students as a portion of their hands-on experience. Complete instructions were developed to guide the

students in establishing communications with the computer and then for calling up the appropriate programs. The simulations had been previously programmed and made available through the T.I.E.S. system.

Procurement of the hardware necessary for presenting the course material was not difficult since all that was needed was readily available as "of-the-shelf" items. Care was taken to locate the most suitable materials keeping in mind the restraints of the budget.

THE RESULTS

Since this program was instituted in September, 1976, only preliminary findings are available for this report. These tentative findings are presented here to provide some information concerning the effectiveness of the program. Complete evaluative data will be stated in subsequent reports of this project.

Evaluation of the results of the program has been and will continue to be made in the following areas:

1. Computer Literacy (the content of the course).
2. Attitude Toward Computers and Computing.
3. Actual Computer Use by the Students and Faculty.
4. Computer Use in Courses Other Than the Introductory Mathematics Course.

The computer literacy of the students was measured through the use of an objective posttest composed of multiple-choice, matching, and questions requiring the students to identify errors in BASIC programming and indicate the corrections needed to enable the program to run. According to the reports by the teachers involved, mastery of the concepts was achieved by the large majority of the students.

Measures of affect concerning computers and computing were to take the form of pre- and post-experience self-ratings. Students were to be asked to rate, on a Likert-type scale, their perceived attitudes toward the various aspects of computers, computing, and the influence of such activities upon their lives. Due to the constraints of a rapid start-up of the program, attitudinal data are to be collected and evaluated on subsequent cycles of this program.

The third area of evaluation related to the amount of computer useage by the students and faculty. For this evaluation, information was collected from T.I.E.S. concerning the actual amount of computer

time assigned to and used by the students. For comparative purposes, these data were related to data from another district high school, similar in key variables except for the use of this computer training program. These data concerning the minutes of computer time assigned and used are displayed in Table 1.

Table 1

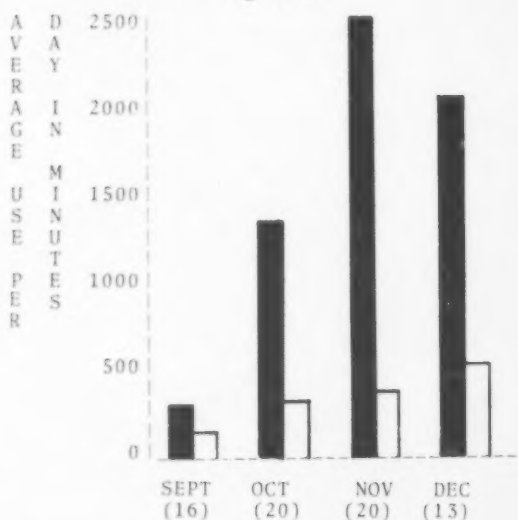
NUMBER OF MINUTES OF COMPUTER TIME
ASSIGNED AND USED

MONTH	PROJECT Assigned	SCHOOL Used	NON-PROJECT Assigned	SCHOOL Used
Sept	12000	4602	9500	2722
Oct	41900	25973	8500	5588
Nov	33621	49700	9200	6602
Dec	36700	27920	9200	6355

In order to obtain a more accurate comparison of the relationship between the two schools with respect to use of the computer, the number of minutes of computer use per month was converted to average number of minutes per day, for each month, since there were large variations in the number of school days for the months reported. The numbers in the parentheses below each month indicate the number of school days for that month. The project school is indicated by the darkened bars.

AVERAGE NUMBER OF MINUTES
PER DAY PER SCHOOL

Figure 1



For the final area of evaluation, the use of the computer in courses other than introductory mathematics courses, data are now being compiled which will provide not only information as to how much time is being used by other classes, but also as to the actual programs that are being run in the simulation and problem-solving modes. Again, these data will be reported in the subsequent project reports.

CONCLUSIONS

While continuous modification and adjustments are being made to the program, the initial results are very positive and are now being further analyzed. Even without the complete analysis of all data collected in this project, it has become

evident that the basic goals of the program are being reached. Through the use of specially prepared instructional materials and the careful selection of the units to be presented, it has been possible to use college level material with high school students. While initial findings indicate the need for several minor modifications, the consensus of the 900 students involved in the study was that the program was indeed worthy and should be continued. Thus the basic goal of the project was reached in the development of an awareness of computing in a variety of applications. In addition, the teachers were also provided with the knowledge required to make appropriate use of computers while teaching in their various subject-matter areas.

BIBLIOGRAPHY

Bell, Norman T. and Allan J. Abedor, Guide For The Development of Audio Visual Instructional Materials. Englewood Cliffs, New Jersey: Educational Technology Publications, 1977

"Making It Count", Seattle, Washington: Boeing Computer Services, 1974

Report of the President's Science Advisory Committee, Computers in Higher Education, Washington, D.C., The White House, 1967

A MINI-COMPUTER BASED LIBRARY CIRCULATION AND FINDING SYSTEM

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The application of bar code technology and the use of a data base manager in the development of a Library Circulation and Finding System are discussed. The design choices and the implementation alternatives that were considered at Virginia Polytechnic Institute and State University are high-lighted. The costs associated with the system are summarized along with the potential benefits. The future development plans are outlined.

The Library Circulation and Finding System discussed here is implemented at the Newman Library at Virginia Tech. Virginia Tech is an educational sanctuary that is located somewhere between the Blue Ridge Mountains and the Appalachian Mountains in southwest Virginia. We have a student population of 19,500 and a faculty and staff of 5,000. So the library has approximately 25,000 patrons to serve. The library has a collection of one million volumes and is growing at the rate of approximately 10% per year, or 100,000 volumes each year. The manual circulation system was becoming totally inadequate to handle the 225,000 circulation transactions that we have each year. As a result, a computerized Circulation and Finding System was proposed for the Newman Library. The system is now operational. This paper presents some of the more interesting aspects of the system.

In order to support circulation alone it is necessary only to use absence files. Absence files imply that a machine readable record be kept of only those items that are currently in circulation. Typically, this would be anywhere from 5 to 15% of the entire collection. Thus, a system based on absence files would require less resources than one that is predicated on having the entire collection in machine readable form. Very early in the decision making process it was agreed to have a system based on the entire collection being in machine readable form. Whereas this approach is initially more expensive to implement, it has some significant long term benefits. For instance, it allows for a computer based searching and finding capability which would not be possible otherwise.

It permits the production of microfiche catalogs that can be easily distributed to locations within and outside the University. It allows for a proper monitoring of the usage and trends in the library collection.

System Capabilities

The design and implementation of the system was divided into two phase. Phase I of the system involved the development of the functional aspects of the system. Phase II, not yet implemented, involves the development of management analysis reports and statistics. Phase I is divided into four functional areas. They are:

1. Circulation control functions
2. Searching and finding functions
3. Data entry functions
4. Backup recovery and other utilities

A list of the functional capabilities of the system is presented. A reader interested in detailed description of these functions is referred to (1).

1. Creates a new record on any item in the library. This record contains the following information:
 - a. Identification number
 - b. Call number
 - c. Author
 - d. Title
 - e. Brief bibliographic information, including such information as publisher, publication date, copy, and volume.
2. Modifies an existing item record. This includes deleting or changing any or all of the fields in the record.
3. Creates a new record for any patron. This record contains the following

information:

- a. ID number
 - b. Initials
 - c. Category
 - d. Circulation code
 - e. Delinquency code
4. Modifies an existing patron record. This would include deleting or changing any or all fields in the record, except the ID number. Also, when needed, name and address information is obtained and stored.
 5. Provides checkout facility which performs the following:
 - a. Identifies delinquent patrons
 - b. Identifies non-circulatable item
 - c. Automatically determines loan periods based on patron category (e.g., faculty, undergraduate, graduate)
 - d. Allows for loan periods that are not of normal length for any given item.
 6. Provides check in facility which performs the following:
 - a. Automatically clears patron record
 - b. Identifies items which should be held
 - c. Displays information pertaining to holds on items being checked in.
 - d. Identifies items which were recalled
 - e. Displays information pertaining to recalls on items being checked in.
 7. Provides a hold facility which performs the following:
 - a. Stores requestor's ID number in hold queue
 - b. Identifies the ID number and the associated hold items.
 8. Provides a recall facility which performs the following:
 - a. Stores requestor's ID number in recall queue
 - b. Associates the ID number with the item which should be recalled
 - c. Automatically calculates date when item may be recalled.
 9. Prints recall notices on a periodic basis.
 10. Provides access into the bibliographic data set using any or all of the following:
 - a. Library of Congress call number
 - b. Item identification number
 - c. Author/Title/Publication year key or portions of it.
 11. Prints overdue notices on a periodic basis.
 12. Provides access into the patron data base using ID number.

In addition to the above functions, the system also has software utilities and application programs which control the following functions:

1. Unloads and reloads of data base
2. Backup procedures for the data base
3. Restoration of the data base, after a disc crash, by using the transaction log tape and a backup copy of the data base.

Bar Code Technology

One of the primary objectives of the system was to provide a quick and efficient method for the check-in and check-out process. In order to facilitate this it was necessary to have a machine readable record associated with each item in the collection and with each patron using the Library. Whereas there are many ways of accomplishing the above, two options were seriously considered: magnetic strip labels and bar code labels.

An evaluation of the two alternatives indicated that the use of bar code labels was by far the more attractive alternative. The bar code labels were less expensive and easier to handle. These labels could be placed directly on the top left hand side of the book and inside (or outside) the plastic laminated ID cards that the students and staff were currently using. If necessary, the labels could be produced in house on inexpensive equipment requiring almost no prior operator training. Most importantly, the light pens (to read the labels) were commercially available and with no hardware changes would interface with the video display terminals that were necessary for other functions. This would be relatively inexpensive (under \$2200) and would have full video terminal and light pen capability using "off the shelf" equipment. In addition only one data communication line would be needed to support both the light pen and the terminal. Accordingly, a barcoded label was (or will be) placed on each item in the entire collection. This barcode label is machine readable and uniquely identifies the item. The ID-numbers of all patrons are also barcoded on the ID-cards. The checkout process simply consists of running a light pen (which reads the bar coded labels) across the labels on the books to be checked out. This essentially completes the check-out process for the operator since the system automatically assigns the due dates for the items.

Data Base Manager

Perhaps the next most important decision associated with the system was the specification which called for the use of a data base manager to organize and handle the data. Conservative estimates indicated that a library collection of approximately one million volumes would require at least 200 million bytes of

storage (data and pointer overhead). Further, because the system was conceived to be a completely transaction oriented, on-line system with no hard copy backup it appeared almost essential to have a data base manager with reliable and dependable backup and recovery procedures.

Virginia Tech already had the IMS data base system for all its administrative applications. Based on prior experience, it was felt that IMS or a data base manager similar to IMS should be used to develop the library system. Since IMS already existed on campus it was logical to consider it as a base for the library development. After an in-depth study it was concluded that a library system based on IMS running on an IBM 370/158 would not be cost effective. This conclusion was based on the estimate that 1,500,000 transactions would be processed by the Library per year, requiring 750 cylinders of storage. The number of transactions presently being processed for the other systems controlled by IMS is estimated to be 1,300,000 per year, requiring 780 cylinders of storage. Thus, the Library Circulation and Finding System alone would require almost as much storage and demand that more transactions be processed than all the other systems combined. Based on this, it was felt that such demands on the present IBM S/370 would put too great a burden on it thereby reducing the effectiveness and efficiency of those IMS systems already in operation.

Another important consideration was the fact that currently IMS is on-line from 8:00 AM to 5:00 PM Monday through Friday. The library hours are much longer and would require IMS to be on-line for 50 additional hours each week. The cost of doing this was prohibitive. As a result, it was concluded that the Library system should be developed on a stand-alone, dedicated, mini-computer system that had a data base manager.

Several mini-computer systems were evaluated (see 2) and it was decided to implement the library system on a Hewlett-Packard 3000 mini-computer using the IMAGE/3000 data base manager.

Costs

The current equipment configuration is as follows:

- | | |
|---|--|
| 1 | Hewlett-Packard Model 3000C 300-50CX system with 128 K bytes of core |
| 1 | Model 30118A 200 lpm printer |
| 2 | 47 million bytes disc and controller |
| 1 | Software package |
| 1 | Basic library package per VPI&SU specifications |

- | | |
|----|-------------------------|
| 13 | Video display terminals |
| 5 | Linear scanners |

This represents a hardware cost of \$195,000. In addition \$6,000 was spent in room preparation and air-conditioning. The major item in supplies and materials was the bar coded labels. These were purchased at the cost of \$14.28 per thousand.

The costs associated with operator training and user education was minimal. However, it is clear that the major cost of the system will be for data entry. It is necessary to put bibliographic information on one million records into the system. This is a slow and expensive process. Currently, four data entry operators are entering data into the system at a rate varying between 300 and 500 items per working day.

Future Plans

The stage for the future development of the Library Circulation and Finding System has already been set. The State of Virginia has mandated library co-operation in the Virginia Plan for Academic Co-operation. VPI&SU, as the State's land grant institution, has a responsibility for providing educational opportunities, including the opportunity for access to library services, to all citizens of the State. A pilot project is under consideration that will extend the system to include three more institutions that belong to the Western Region Consortium for Higher Education in Virginia.

In addition to extending the capabilities of the existing system to other institutions, plans are underway to develop Phase II of the system which will provide various management reports showing circulation, usage, and cost patterns of the library. This information will be used to better manage the library's limited resources on which increasing demands are being continuously placed.

References

- (1) Detailed Documentation of Library Circulation and Finding System, Systems Development Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1976.
- (2) Proposal for the Acquisition of an Automated Library Circulation and Finding System, Systems Development Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1975.

A MODULAR APPROACH TO
MANAGEMENT INFORMATION SYSTEMS
(MIS) FOR
EDUCATIONAL INSTITUTIONS
L. RICHARD IWAN - SYSTEMS ANALYST
TEX-SIS FOLLOW-UP

This paper describes the application of Modular Structuring as applied to development of Computer Based Student Follow-Up System for the Texas Student Information System (TEX-SIS). This system stresses modularization of all MIS elements including such items as source instruments (questionnaires), data translation, computer processor architecture, data base structure, and support documentation. The TEX-SIS MIS, as it has evolved, is configured with heavy emphasis upon adaptability and accommodation to institutions from both administrative and research/development perspectives.

Presentation Prospective - This paper has been compiled, and is presented, from a data processing prospective, as interpreted by data processing personnel. Conscientious effort has been exercised to present this material in an honest and unbiased manner. There may, however, occur some variance with respect to material, as presented herein, and material which would be emphasized were this paper presented from a prospective other than that of data processing.

Historical Overview - As a result of Texas legislation which stated that funds "shall be expended for the purpose of developing data directly relating to programs conducted by public junior colleges and shall be for the purpose of developing systems for the use of junior colleges," the Texas Education Agency (in cooperation with an Advisory Committee of two-year college educators) invited proposals, and ultimately selected Tarrant County Junior College, Fort Worth, Texas as the prime contractor for the development of a Student-Follow-Up-System. Subsequently, a research and development group was formed; this group, designated "Project Follow-Up," functioned during the period of 15 May 74 thru 31 August 76 in a system design and functional validation capacity, ultimately producing a Student Management Information System.

Task Group Structure - An "interesting" characteristic of personnel comprising "Project Follow-Up" was their individual discipline areas, and relative level, of technical expertise.

Project administrative personnel, though unquestionably competent in areas such as vocational education, educational administration and counseling, had little, if any expertise in the area of computerized data processing.

Correspondingly, data processing personnel, though competent in their primary areas of technical responsibility (system design and data processing), did not always have similar comprehension in some important areas outside of system design and data processing.

Such non-overlapping diversity in project personnel background, on occasion, tended to create difficulties with respect to interdisciplinary communication processes such as precise interpretation of tasks which would be required, how these tasks were to be addressed, and the relative complexity of such tasks.

General Philosophy - System design developed in support of Project Follow-Up data processing was configured such as to afford a reasonable balance between what is ideal, and what is realistically attainable.

In developing any information management system, it is natural tendency to generate mechanisms which are ideally suited to the specific operating environment in which they are developed.

Such an approach, however, often yields a system which may be very comprehensive and effective in one type of institutional data processing environment, but is only marginally usable when removed from this restrictive environment and applied to educational institutions with varying computational hardware, data-base organization, or administrative priorities.

Thusly, an integral characteristic of fundamental design philosophy was an initial recognition that every individual educational institution is an autonomous environmental entity with uniquely distinct requirements and priorities.

In accord with this fundamental design philosophy, it was established that the end-product information management system mechanism would not be "system bound" to its developmental environment, but rather, comprized of independent "stand alone" analysis modules with emphasis toward flexibility and adaptability to varying requirements and environments.

Collectively, these independent "modules" complement the processing functions of one-another to configure the "total" processing "system".

Depending upon specific requirements, of an individual institution, applicable discrete elements, or "modules" of the "total system" can be intergrated to configure an individualized information management system fulfilling that institutions unique follow-up data processing needs.

This "modular concept" was extended to all applicable phases of system development, including such items as information source instruments, source information translation, data base structure, analysis processor architecture, and support documentation.

It should be duly noted, that although the Student Follow-Up System described herein was created primarily to fulfill needs associated with public junior

college usage, due care was exercised throughout its mechanization to provision for bilateral extension of system implementation to secondary school and/or senior college applications, should such requirements be established.

Task Definition - As with many efforts, the most difficult problem to be addressed may often be definition of the actual problem, itself.

Early during the period of task definition, the SCOS-DELPHI study was conducted on a statewide basis in effort to establish consensus of opinion regarding the desirable characteristics of a follow-up system. This study identified and defined areas of general follow-up interest; specifically, an information "system," which was, itself, divided into fundamental "sub-system" modules; each "sub-system" correlating with information relating to unique, definable, areas of follow-up interest.

In-depth analysis soon established that no single questionnaire instrument could realistically retrieve all of the information which would be needed for the various "sub-system" areas; moreover, some of these areas would require several unique questionnaire instruments to afford the desired level of information stratification.

Information Source Instruments - Upon acceptable identification of essential questionnaire instruments to be generated, each respective instrument was broken down into component "sub-modules" which identified, by general category, the type of source information (demographic, questions, etc), which would be required. Subsequent definition of individual questions associated with each "sub-module" was not, however, quite as straightforward a task as was initially expected; identification of information you need is one thing; definition of appropriate questions to retrieve such information may be a somewhat different matter.

Existing specimen questionnaire having content similarity to information associated with component "sub-modules" were collected from various sources and examined for applicability. Questions which seemed appropriate were extracted from the specimen instruments, classified by general area of content, edited, and,

finally keypunched.

Additionally, appropriate questions originating via the SCOS-DELPHI study; extensive interviews and discussions with state advisory committee personnel; and similar contact with individual educational institution personnel were classified, keypunched and added to the specimen questionnaire data base.

The resulting composite source question data base was sorted by question area classification, and printed; yielding a reasonably usable collection of "real world" question "modules" from which to select prospective questions for actual questionnaire instruments.

Individual component "sub-modules" were then populated utilizing material from this question data base, plus additions and/or modification, as applicable, to produce the initial configuration of each unique questionnaire instrument.

Source Information Translation - Source Information originating via student questionnaire instruments require translation into a machine-processable data medium prior to computer analysis. Standard 80-column punched-card data records were utilized for this purpose to facilitate compatibility with respect to various institutional processing environments throughout the educational establishment.

A standardized source data record was adapted to facilitate efficient processing and provisions for student (data) flow monitor capabilities. Data associated with each questionnaire-type source instruments was translated into a machine-processable logical record consisting of two, or more, punched-card data record, the exact number of such records being a function of specific questionnaire requirements.

The standardized data format is characterized by all questionnaire data records being comprised of two distinct sections; specifically, an Identification Section, and a Data Section. All data records incorporate a uniform Identification Section which contains essential indexing information necessary for effective processing in a multi-institutional environment. The Data Section, as its name implies contains, the actual processable data associated with each

record.

The Data Section of the first record contains logistical and analysis stratification information, and is uniform for all questionnaire configuration; like, or similar, information will always populate the same unique data-field record assignments. The Data Section of each subsequent questionnaire record is dependent upon the specific source instrument being translated, with individual student responses to questionnaire questions populating data items.

Data Base Structure - The modular concept, as applied to data base organization, is characterized by the total "system" data base being comprised of individual data base "modules"; correspondingly, the functional processing data base associated with typical individual analysis requirements consist of one, or more, individual component "modules", as applicable, to the specific task.

The data base module technique affords several distinct advantages. Total machine-processable storage requirements associated with any given processing task are minimized, functioning to simplify programming task and premitting usage of computers having smaller storage capacity than would otherwise be required. Processing execution is minimized thereby reducing cost associated with any given analysis task. Data base revisions of source questionnaire design tend to be localized; thusly, minimized time and effort required for mechanization.

It is recognized that some educational institutions, particularly those having extensive data processing resources, may find it desirable to combine individual data base "modules" into a comprehensive integrated data base system. Appropriate identification indices germane to such modular integration have been incorporated into the Identification Section of all individual data records to expedite such processes. Due to the unique "system bound" nature of such integration processes, however, tasks of this category are relegated to the responsibility of institutions, so concerned.

Analysis Processor Architecture - As a function of the varied individual characteristics associated with unique source questionnaire instruments, analysis report format and stratification potential was limitless. In an attempt to achieve reasonable accommodation to what was realistically attainable, architecture for computerized analysis processors for these instruments was essentially standardized into three fundamental configurations. Two of these configurations analyze data in a manner oriented toward usage by the individual educational institution; the third type is specifically configured to support analysis associated with state agency requirements. Each unique processor is comprised of discrete program "sub-modules", many of which are common to all processor configurations.

The first local analysis configuration is characterized by data for analysis being accumulated, and then summarized, by distinct predefined classifications, such as student major, sex, race, degree program, and general curriculum area. Analysis profile reports are generated which reflect questionnaire response stratified by these classifications.

The second local analysis configuration is characterized by input data being logically sorted by course identification parameters such as; course department, course number, and course section. This sorted data is accumulated and stratified by sorting criterion, and appropriate summary type analysis reports generated.

Additionally a uniform student demographic analysis module which documents race and sex distribution is incorporated into all local analysis processor configurations; print-out of this information is optional, and can accompany all levels of analysis stratification.

Analysis associated with state agency level follow-up differs significantly from that required for local institution usage in both content and analysis format. As a function of such characteristic, modular commonality for this type of processor is not as great as occurs between individual local analysis processors.

Support Documentation - Documentation associated with the Student Follow-Up System described herein was presented on two fundamental technical levels in an effort to satisfy the individual requirements of both administrative personnel, having limited requirements and expertise in data processing, and also, technical practitioners having responsibility for actual data processing.

Information of general interest was documented in a basic data processing manual; itself, organize into several "sub manuals", each being dedicated to a specific area of the system.

Specific, and more detailed, technical information of interest primarily to those persons actually involved in data processing, was documented in individual technical appendices provided to interested user upon their request.

System Implementation - The Management Information System described in this paper is presently in an implementation phase; coordinated and funded, on an annual basis, by the Texas Education Agency. Technical support for this effort is being provided via sustaining contract to the Texas Student Information System (TEX-SIS); TEX-SIS being comprised, essentially of Project Follow-Up personnel charged with original system design. TEX-SIS is currently providing technical support, in various degrees of participation, to almost 100% of the public community colleges in the state of Texas; moreover, almost 20% of these institutions are also directly involved in related data processing activities.

Support to local institutions by TEA and TEX-SIS include such data processing activities as counseling individual follow-up requirements, printing of questionnaire instruments, translation and/or analysis questionnaire data, and technical assistance to institutional data processing organizations in their implementation of TEX-SIS developed data processing technology.

State level implementation activities include recent completion of two statewide follow-up studies of Occupational/Technical Student using an optically scannable questionnaire instrument. Analysis relating to these two studies was executed on both statewide composite and individual institutional levels.

A SALARY SOLVENCY MODEL
OR A FACULTY FLOW MODEL

H. P. Nicely, Jr.
Miami-Dade Community College

A computerized model is described for gaming possible future salaries and salary policies at institutions of higher learning. This planning simulation model is examined with respect to methodology, inputs, outputs, and flexibility -- focusing on its value as a decision-making tool to administrators.

STATEMENT OF THE PROBLEM

Many colleges today are in financial "hot water" because they lack the capability to plan with enough reaction time to avoid devastating financial problems. In a typical educational institution, the salaries of full-time employees represent the largest single operating expenditure. Therefore, the reason that many colleges have found themselves in financial difficulty is because they have been unable to control such expenditures.

The statement of the problem which is addressed by the Salary Solvency Model is as follows: In order to avoid catastrophic consequences, the long range financial impact of proposed salaries and salary policies should be considered carefully by educational institutions prior to their implementation.

BRIEF DESCRIPTION OF THE MODEL

The model is a sophisticated simulation tool which can be used in gaming salaries and salary policies at institutions of higher learning. Although specifically developed to meet the needs of Miami-Dade Community College (M-DCC), it was designed with sufficient flexibility to be useful to other colleges and universities.

Furthermore, the computer program for the model was written in American National Standard (ANS) COBOL so that other educational institutions and even companies can use the model with a minimum of modifications.

Gaming from one to ten years in the future was an important design requirement. Also, the gaming of certain policy changes was an important consideration. For example, it was desirable:

1. to be able to impose a hypothetical quota for each academic rank (or job code),
2. to be able to change the mandatory retirement age,

3. to be able to change the percentage of the total number of personnel permitted to be on a one-year leave with pay.

Colleges making use of this model must be in an environment where the total dollars available for all salaries are, generally speaking, invariant with time, assuming a status quo enrollment and no inflation. In such a case, the dollars required for paying increases to people on board must be obtained by new hires being employed at salaries less (or far less) than the salaries of the personnel whom they are replacing.

Technically, the model is a "Modified Markov Chain, Monte Carlo Simulation," a phrase which will be defined subsequently. The computer programming was done in such a manner that the model can readily be used by other colleges.

Although, in the foregoing discussion, enrollment was assumed to be constant, and inflation was assumed to be non-existent, the Salary Solvency Model is designed to accommodate both specified enrollment changes and an inflationary rate.

In order to make practical use of the model, it is important to develop "hard" or reliable probabilities. This is a time-consuming and very important aspect in using the model successfully.

It is believed that the Salary Solvency Model will make a significant impact in long range planning at Miami-Dade Community College. For example, it is believed that some existing policies might likely be altered as a result of the simulation findings.

The Salary Solvency Model will enable executives at an educational institution to explore options and to make decisions with enough lead time so that catastrophic problems (for example, bankruptcy or insolvency) can be avoided. Stated in

a more positive way, this model will permit upward adjustments to a salary schedule to be investigated and declared fiscally sound prior to implementation. Accordingly, higher salaries of both remaining and new employees might be recommended than would otherwise be the case if no gaming had taken place.

Dr. Robert McCabe, Executive Vice President of Miami-Dade Community College, is responsible for the economic concept upon which the Salary Solvency Model is based. Dr. McCabe (1974:1) wrote the following concerning this model:

The 1950's and 1960's were years of tremendous growth for American higher education, especially for community colleges. A number of factors combined to bring a tripling of colleges enrollment and unprecedented increases in support - expenditures for higher education increased sevenfold! During the 1960's, colleges struggled to adjust their programs to meet dramatically changing societal needs. Toward the close of the decade it was evident that public enchantment with higher education had diminished. The 1970's began with an emphasis on cost analysis and cost consciousness, and it now appears that higher education must plan to perform its functions with no increase in resources. In Florida, the community colleges are funded based on a cost analysis system, with the only increase in income per student being that which is caused by inflation; thus the spending power per student will remain constant. Patterns similar to that in Florida are emerging throughout the country.

In public community colleges, as in many other governmental organizations, incremental salary schedules are customary. Institutions usually adopt salary schedules on the basis of their capacity to pay for that schedule during the first year of the adoption. With no greater understanding of the impact of incremental salary schedules, it is a virtual certainty that the total salary expenditure will increase annually, even when no additional personnel are added. During the growing years of the 1950's and 1960's, these increases were accommodated by additional income.

When income must be projected as stable, it is necessary to stabilize salary expenditures while utilizing incremental salary schedules. If this is not done, the community colleges will face the same problems as so many urban public school systems, where salary expenditures have grown more rapidly than income. When this happens, reductions must be made in services which ultimately reflect in the quality of programs. The typical pattern has been to begin by reducing long-range maintenance, which in the long run brings even greater financial pressure. The next area to be cut is usually day-to-day maintenance and custodial and then special services and specialized personnel. Ultimately all flexibility is lost and only the most primitive learning environment can be provided.

In theory, it is possible to control the growth of salary expenditures by controlling the salary of incoming personnel. The difference in salary between people dropping out of the system and their replacements provides the money necessary to pay increments to those not at ceilings. Control of the salaries of incoming personnel has additional benefit, as it is desirable for an institution to maintain a distribution of ages on a staff. Of all factors, age has the highest correlation with salary.

This model is an attempt to apply this theory - - using the techniques of gaming - - in order to project the impact of any proposed salary schedule or to predict the mean salary for new personnel under conditions permitting nothing other than zero salary expenditure growth for any salary schedule. Successful application should allow the maintenance of a constant percentage of expenditures for salaries. Any new funds that may become available to an institution because of inflation or other factors would allow salary schedules to be improved. The new income would be free for application for increased operational expenses as well as improved salaries, rather than being required for salary schedule maintenance. This should result in considerable benefit. It would help the institution in managing its finances, as it could stabilize its largest expenditure - - salaries. It would also be beneficial to individuals in the system, as it would be more possible to improve salary schedules.

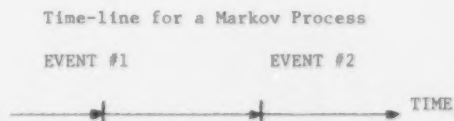
METHODOLOGY DISCUSSION

The Salary Solvency Model can be considered a "Modified Markov Chain, Monte Carlo Simulation." An explanation for this definition follows.

Markov Process

A time-line that is basic to an understanding of a Markov Process is given in Figure 1.

Figure 1



In a Markov process, changes (or "transitions") occur or can be assumed to only at one or more events. No changes occur between events! A second criterion for a process to be Markovian is that probabilities associated with an event are not dependent on the outcome of the preceding event.

Personnel practices such as hiring and terminating at a college were assumed to be Markovian for the purpose of this development. This necessary simplifying assumption was possible because of the negligible error introduced thereby. A Markovian process would assume that all events

occurring during a year can be considered as having occurred at the same time, probably the beginning of the year.

In a Markov process, it is convenient to think in terms of "states" prior to an event and "states" following the event, with a "probability transition matrix" or "transition matrix" containing the probabilities of going from one state to the others when the event occurs.

To develop an illustration, an instructor will be considered who is at the institution before "Event #1." (Event #1 could, for example, be the beginning of the 1975-76 year.) The input state for Event #1 is thus simply "instructor." Typical output states of Event #1 would be as follows:

1. Instructor,
2. Assistant professor, and
3. Termination

The transition matrix for Event #1 is described in Figure 2.

Figure 2

Output State Probabilities Considering One Input State				
OUTPUT STATE PROBABILITIES				
Instr. Asst. Prof. Term.				
INPUT STATES {	Instr.	0.6	0.3	0.1

Each of the numbers above represents a transition probability. For example, the probability of the instructor being promoted to assistant professor is 0.3 (or three chances in ten).

Figure 3 was obtained by expanding the one input state transition matrix (Figure 2) to include "assistant professor" as an input state.

Figure 3

Output State Probabilities Considering Two Input States					
OUTPUT STATE PROBABILITIES WITH TWO INPUT STATES					
Instr. Asst. P. Assoc. P. Term.					
INPUT STATES {	Instr.	0.6	0.3	0.0	0.1
	Asst. P.	0.0	0.7	0.2	0.1

Each zero in the matrix indicates that that particular transition is not possible. Each set of output probabilities is mutually exclusive and exhaustive, and the sum of all probability sets has to equal one.

It is often convenient to think of a series of events. This is the case with the Salary Solvency Model where ten events (or ten "year-beginnings") can be considered at maximum. When more than one event is involved in a Markov process, it is convenient to use the terminology "Markov Chain."

Modified Markov Process

Considering at Miami-Dade Community College all positions on all payrolls and all steps possible, there could likely be about 1,000 unique input states. This means that the full matrix for Event #1 only would be an astronomical 1,000 by 1,000 in size, thus requiring 1,000,000 cells for all probabilities.

It is customary in Markov processes to describe the entire transition matrix. However, because of the vast size of such a transition matrix (and the computer memory requirements therefor) and because of the fact that most cells would have a zero probability, a technique was used in which only the most likely transitions are considered. All other transitions are assumed to be zero. This is what is meant by a "Modified Markov Process."

This technique requires that categories of employees where promotions are likely be processed separately. Fortunately, the three payrolls at M-DCC (classified/staff, administrative and instructional) met this criterion for categorization. This development focused on the application of the Salary Solvency Model to the instructional payroll. In so doing, promotions or transfers from other payrolls to the instructional payroll and vice versa were assumed to be negligible with respect to gaming findings.

Monte Carlo Simulation

In order to lay the foundation for the next discussion, it was assumed that there were a hundred candidates for transition from an input state to output states for Event #1. In using a non-Monte Carlo (or analytic) simulation, the hundred candidates would be distributed to the possible outcomes as closely as possible to fit predicted outcomes.

When the number of candidates for any one probability cell is very large, a non-Monte Carlo (or analytic) simulation can be quite accurate. When the number of candidates for any one input state is, say one, then the most likely outcome must be hypothesized in a non-Monte Carlo simulation. At M-DCC there are some 2,000 employees who are candidates for approximately 1,000 input states and a much larger number of probability cells -- considering Event #1 only. When one considers two or more events, the number of candidates for any unique sequence of events approaches zero in all cases! In practical terms, this means that a non-Monte Carlo (or analytic) simulation for this problem would become increasingly inaccurate after the second year. Thus a Monte Carlo solution was indicated.

In a Monte Carlo simulation, a random number is generated and used to decide the outcome of each probabilistic occurrence. In practical terms, random numbers are used in the Salary Solvency Model to predict the fate of each person going through the one to ten years of the simulation. For any one trial Monte Carlo run, these random numbers decide whether the person is promoted, terminates, dies, etc. The probabilities used for each of these occurrences should be based on the best historical and actuarial information available.

One full Monte Carlo simulation is never adequate to describe a process. Instead, usually many hundreds or thousands of simulations are computed, and the averages (or means) are used. In the Salary Solvency Model, the number of Monte Carlo runs desired for any one computation of means and standard deviations can be specified as an input parameter.

The principle disadvantage of a Monte Carlo simulation is that it is time-consuming on a computer because of the need for many iterations. Through trial and error, the number of production runs can be optimized in the application of the Salary Solvency Model to produce a reasonable compromise between accuracy and cost of output. Standard deviations are especially useful in this optimization process.

When more than two output states are possible, the transition matrix, discussed earlier, must be converted to a table of "cumulative probabilities" so that a random number can indicate the outcome selected. Figure 4 illustrates the first transition matrix described in the preceding section (Figure 2) after conversion to a table of cumulative probabilities.

Figure 4

Matrix of Cumulative Probabilities

OUTPUT STATE CUMULATIVE PROBABILITIES				
Instr. Asst. Prof. Term.				
INPUT STATES {	Instr.	0.6	0.9	1.0

Assuming that a random number can be generated with a value of from 0 to 10 inclusive, any random number generated will be divided by 10 so that it can be considered a probability with a range of 0.0 to 1.0. Let z = random number.

Then:

1. if $0 \leq z < 0.6$, the instructor is declared to remain an instructor at Event #1.
2. if $0.6 \leq z < 0.9$, the instructor is declared to be promoted to assistant professor at Event #1.

3. if $0.9 \leq z \leq 1.0$, the instructor is declared to be terminated at Event #1.

INPUT SPECIFICATIONS

The input specifications for the Salary Solvency Model can be categorized under three headings:

1. Run Identification and Miscellaneous Tables and Data Elements
2. Personnel/Payroll Extract Data Elements
3. Gaming Parameters

The term "run identification" is self explanatory. One of the required tables consists of mortality probabilities as a function of age and sex. Another input table consists of transition probabilities based on historical information. The data elements required include the "optional retirement probability by age", the "identity of the base year", the "total number of years being forecast", the "number of Monte Carlo iterations desired", and "a Monte Carlo seed number".

The following data elements pertaining to the personnel/payroll file have to be supplied in the form of the magnetic tape record for each full-time employee being investigated in the gaming run:

Element Description	COBOL Picture
Record sequence number (e.g., 143)	9(4)
Age (e.g., 47)	9(2)
Base annual salary (e.g., \$14,936)	9(5)
Number of years at college (e.g., 9)	9(2)
Number of years in retirement plan (e.g., 11)	9(2)
Sex: M or F (e.g., M)	X(1)
Job Code (e.g., 5)	9(4)

This extract is produced from the master personnel/payroll file of the college. Developing this extract may involve some simple calculations. For example, "age" for the initial application of the Salary Solvency Model at M-DCC was computed using the run date and the employee's birthdate.

Unwanted records should be inhibited at the time the extract is made. For example, during the initial application of the Salary Solvency Model at M-DCC, all payroll records were inhibited except those for full-time employees on the instructional payroll.

For each year being forecast, the following data elements associated with gaming parameters have to be given:

<u>Element Description</u>	<u>COBOL Picture</u>
Year (e.g., 1975-76)	X(7)
Enrollment in terms of FTE students (e.g., 30,534)	9(5)
Leave percentage - - percentage of employees expected to be on a one- year leave with pay (e.g., 1.5)	9V99
Inflationary rate applied relative to the preceding year (e.g., 8%). A negative sign indicates deflation.	S99V99
Flag (Y or N)* indicating if salary minimum is to be adjusted upward corresponding to inflation (e.g., Y)	X(1)
Flag (Y or N)* indicating if salary maximum is to be adjusted upward corresponding to inflation (e.g., Y)	X(1)
Flag (Y or N)* indicating if salary increment argument is to be adjusted upward corresponding to inflation (e.g., N)	X(1)
Mean age of a new hire (e.g., 33)	9(2)
Probability of any new hire being male (e.g., 0.50)	V9(4)
Mandatory retirement age (e.g., 70)	9(2)

The foregoing requirements also apply to the base year, in which case each element is optional except for "Year".

For each position type, the following data elements have to be furnished for the base year only:

<u>Element Description</u>	<u>COBOL Picture</u>
Job code (e.g., 1)	9(4)
Replacement job code (e.g., 4)	9(4)
Salary minimum - - to nearest dollar (e.g., \$16,693)	9(5)

*Y = Yes, N = No

Salary maximum - - to nearest dollar (e.g., \$22,958)	9(5)
Salary increment code; F or P (e.g., F)	X(1)
If Code F, salary increment argument is annual increment to nearest dollar (e.g., \$540)	9(5)
or	
If Code P, salary increment argument is annual increment expressed as a percentage (e.g., 3%)	9(2)V9(3)
Quota (e.g., 75) A value of 99999 indicates an "unlimited quota" or "no quota"	9(5)
Enrollment constant A (e.g., 0)	9(5)
Enrollment constant B (e.g., 0.002718)	V9(6)
Number of open positions (e.g., 2)	9(5)
In addition, the "Percent of range" has to be given for any new hire.	

OUTPUT SPECIFICATIONS

The output consists primarily of one or more pages for each year being forecast. One row of data elements is reserved for each position type, and the last row is reserved for totals (by year). Data elements printed out for each row of data are as follows:

<u>Element Description</u>	<u>COBOL Picture</u>
Job title	X(22)
Job code	9(4)
Replacement job code	9(4)
Adjusted quota	ZZ,ZZ9
Enrollment constant A	ZZ,ZZ9
Enrollment constant B	9.9(6)
Predicted mean number of new/remaining employees	ZZ,ZZ9.99
Predicted mean salary of new/remaining employees	ZZ,ZZ9
Adjusted salary minimum	ZZ,ZZ9
Adjusted salary maximum	ZZ,ZZ9
Salary increment code (F or P)	X(1)

Adjusted salary increment argument	ZZ,ZZ9
Predicted mean number of new employees	ZZ,ZZ9.99
Predicted mean salary of new employees	ZZ,ZZ9
Predicted mean number of surplus employees	ZZ,ZZ9.99
Predicted initial optimum number of new/remaining employees	ZZ,ZZ9
Predicted mean optimum number of new/remaining employees	ZZ,ZZ9.99

Standard deviations for selected data elements are printed on a separate data line immediately below associated data elements.

The format for the base year is identical to the format for the forecast years except that certain data elements not available are not displayed, and appropriate column headers are inhibited.

The output for each page or pages pertaining to any one forecast year contains the following data elements in the header:

Element Description	COBOL Picture
Title "SALARY SOLVENCY MODEL"	Not Applicable
Computer run date	Not Applicable
Run identification information	X(132) for each of two lines
Year being forecast	X(7)
Enrollment	9(5)
Inflationary rate	X99.99
Leave percentage	9.99
New hire male/female mix	.9999/.9999
Mean age of new hire	99
Mandatory retirement age	9(2)
Number of Monte Carlo iterations	9(5)
Random number generator seed number	4(N)
Mean age of all employees	99.99
Mean number of years at institution	99.99

Attached as an Appendix is a sample run for M-DCC which illustrates the application of the Salary Solvency Model to the instructional payroll for ten forecast years: 1975-76 through 1983-84. In this example, the enrollment is considered constant and inflation is considered to be non-existent. Please note that the computer-printed page number 1 refers to the base year 1974-75; page number 2 refers to the forecast year 1975-76; etc. In this particular run it is interesting to see that although the total payroll for instructional personnel increases slightly for two years, the long term trend for the total payroll is slightly downward. Therefore in this particular simulation, it would have been possible to have granted a slight blanket increase to all personnel and still have maintained salary solvency over the ten-year period.

GROUND RULES AND ASSUMPTIONS

As the Salary Solvency Model was being designed, developed and tested, a number of ground rules and assumptions emerged:

1. Only full-time employees are considered. Temporary and part-time employees (including student assistants) are not included.
2. The financial impact of supplements, overtime and overload for full-time employees are not considered.
3. The financial impact of fringe benefits for full-time employees are not considered.
4. Instructional personnel who have "basic-year contracts" (10-month contracts) are assumed to have basic-year contracts for all projected years in the simulation, etc.
5. Any random-number-generated decisions made during any one forecast year are assumed to have occurred at the beginning of that forecast year.
6. As the Salary Solvency Model "hires" an employee for a year, he is not subject to any additional decisions for that same year.

INITIAL APPLICATION OF THE MODEL

Approximately 30 runs were made in order to validate the model thoroughly and to test its sensitivity to various parameters. This information (plus all computational algorithms) is contained in the author's doctoral dissertation, which is available at a cost of \$15.00 from the Miami-Dade Community College Bookstore, 11011 S.W. 104th Street, Miami, FL 33176.

About 90 minutes of IBM 370/155 CPU time is presently required for 100 iterations at M-DCC using the instructional payroll of some 1000 full-time faculty and forecasting for a full ten years. This program requires 1,2,000 bytes of storage,

and is written totally in ANS COBOL.

An improved version of the program producing identical data requires 60 minutes of IBM 370/155 CPU time and 164,000 bytes of storage, but this ANS COBOL program requires a subroutine in IBM 360/370 assembly language for the random number generator.

About the time that the model became operational, the State of Florida imposed a salary freeze on all employees for one fiscal year beginning July 1, 1975. Concurrently, an enrollment ceiling was placed on all public institutions of higher learning. Therefore, although the Salary Solvency Model was used by the M-DCC administration to determine the impact of proposed salaries and salary policy changes for 1975-76, none of these changes could be implemented because of suddenly imposed constraints. The Salary Solvency Model was used successfully during the Spring of 1976 as a decision-making tool for salary increases, which became effective for M-DCC faculty during the year 1976-77.

CONCLUDING REMARKS

For institutions which have collective bargaining, the Salary Solvency Model should be particularly useful in determining the long range financial impact of proposals and counter-proposals.

The Salary Solvency Model can be purchased from M-DCC for \$3,000.00 on a satisfaction-guaranteed basis. This purchase price includes a tape and/or card source-language program plus complete documentation. Implementation assistance is also available from personnel associated with the project through private consulting agreements. For further information, contact the Miami-Dade Community College Bookstore, 11011 S.W. 104th Street, Miami, FL 33176, or contact the author at (305) 596-1328.

SELECTED BIBLIOGRAPHY

Lewis, Goodman and Miller. "A Pseudo-random Number Generator for the System/360," IBM Systems Journal, No. 2, pp. 136-146, 1969.

Nicely, H. P. A Simulation Model for Predicting the Long Range Financial Impact of Proposed Salaries and Policies. (A doctoral dissertation). Florida: Nova University, July 1975.

COMPUTER-ASSISTED MANAGEMENT OF SCHOOLS OF MUSIC

David Swanzy
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The heart of the design is a minicomputer, which functions in a timesharing mode. A music learning laboratory is the basic instructional component of the system. Also included are a synthesizer for composition, an information storage and retrieval system for management purposes, a research laboratory, and a music printing component.

The New Technology. Whenever potentials are as far reaching as large networks of computers with storage banks of musical information, problems of selection of materials and approaches set a pace considerably slower than hardware development. In fact, a peak in technical advancements seems needed to allow musicians and educators to examine and standardize future directions. No "peak" is in sight, though, and interested individuals need constantly to expand their thinking and to disseminate new information to the profession.

With the industrial revolution came a technology which allowed for uniformity and mass production. In education, this resulted in standardization of teaching materials, in refined methodology, and in the later development of teaching machines. In music, instruments became more readily available, improved and more durable, and less costly. Sound reproduction was accomplished and improved as mechanical techniques gave way to electronic advancements.

This "old" technology, however great its importance, is nearing its end. In its place is evolving a "new" technology, with vast possibilities for uniqueness and variety. Consider, for instance, the almost endless variety of sounds possible on even the smaller synthesizers. The very technology which provided exactness and precision has been revolutionized to allow for personal choices. The problem of man versus machine--of seeking one's identity and uniqueness in lieu of a number and classification in society--may be solved by technology itself. This is the new technology.

Memory. A basic component of a computer is its memory system. Accurate memory,

whether human or machine, requires that information be received and stored for later output with neither distortion nor partial loss. Reasoning, feelings, and other unique attributes of the human brain involve more than just memory. Admittedly, simulating the human brain and exhibiting human behavior by electronic means (artificial intelligence) are theoretical goals to approach rather than to attain. This limitation, however, is recognized in a sense similar to approaching perfection.

At a low level of intelligence (memory without reasoning), a computer may "know" the rules of a game--chess, for example--and play without breaking those rules. Playing rather than winning is the goal, and although winning is unlikely, each move by the computer will be a legitimate one. In a more advanced state, the computer may be programmed with a library of basic moves which have winning potential--Fool's Checkmate, for instance. Extending this intelligence even more, complex formulas for executing a series of moves in a variety of situations may increase the probability for winning. Finally, reasoning and decisions may closely parallel human action whenever the computer is programmed to learn by its past mistakes as well as by those of its competitor. Without additional human intervention, then, a computer program for playing chess gradually improves as it is used because of its memory and coding power.

Speed. Other than electronic storage capacity, a major inherent capability of computers is execution speed, but the large amount of material which must be stored before a retrieval system becomes valuable requires sophisticated system software as well as advanced hardware.

These techniques are quite advanced, but some of the theories on which they are based may be understood without in-depth study.

A novice programmer may readily grasp the concept of checking the beginning entry of a data file to see if it is the information sought, and if not, moving down the list until the desired information is found or the file has been exhausted. This sequential accessing of material is theoretically equivalent to visually searching for a given word in the dictionary by checking every word from Page One until the desired word is reached. Obviously, this is not an efficient way for a person to find the word nor should it be the electronic technique to be employed. More satisfactorily, an alternative searching technique called random access allows for the search to begin at any location in the file. If the word begins with the letter W, then, the search begins with that portion (assuming alphabetical listing) of the file. The "computer address" of the W's could be identified in a table of alphabetical addresses, or the data could be "partitioned" into separate alphabetical files. The sophisticated programmer has even more discrete ways of partitioning and indexing computer locations of desired information.

Designing the System. Using as the basic hardware the continually refined minicomputer, with one or more interfaces to provide sound control for instructional and musical purposes, software may be developed which could greatly assist in the total operation of a music department. Cost of minis continues to decrease while efficiency, speed, and storage capacity are increasing. Because of this trend and with the fact that large computer networks may provide material of common value to all users, a previous major concern of expense may soon be an asset rather than a liability for computer usage in music and education.

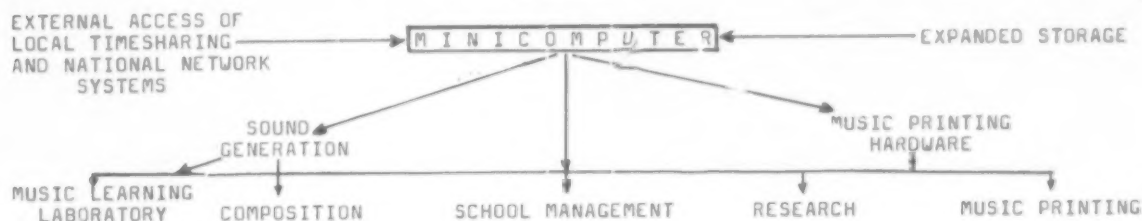
A scheme of this design is presented in Figure One. Note that the versatility of the system allows for simultaneous (time-sharing) as well as dedicated use of a system conceived primarily as a music learning laboratory. The immense number of possibilities for instruction,

composition, research, and even more specialized applications such as music printing have been discussed in many journals. (For more detail of the music lab in this particular system, see "The Versatile Computer" in the March, 1976 issue of Music Educators Journal.) Consideration has been lacking, however, for exploring the potential of specialized management assistance which is usually necessary for a school of music. It should be re-emphasized, in this investigation of potential, that the "new" technology provides uniqueness based on specific needs rather than standardization because of mini-systems, with their increased efficiency, memory, speed, and ease of operation.

Student and Faculty Records. Academic records of students are generally available through the traditional computer center at many institutions. There are at least two major steps which could be taken, in addition, to expand such a service. One is the computerized storage of all information regarding students and faculty traditionally found only in hardcopy format. Updating is more easily accomplished than through traditional means, and compiling complicated and large amounts of desired data becomes a routine task. In addition, a singular type of information regarding an individual frequently needs to be entered into a variety of formats, requiring duplication of effort when non-computerized techniques are used. For instance, consider the compilation of a list of seniors who are performance majors and, at another time, the listing of all vocal performance majors at all levels. The student information would be entered into a data file only once, updated at one location whenever necessary, and the needed lists would be organized and generated in the proper format by computer. Less obvious tasks are equally possible, such as determining an appropriate meeting time for a selected group of students by accessing a data file of current schedules.

Some of the implications of the computer's ability to store, analyze, manipulate, and quickly provide information are as frightening as they are impressive, and national concern is presently being expressed about possible abuses of this technology. Nonetheless, computer collection and

Figure One



dissemination of accurate information for desirable and legitimate purposes offer promising potential.

A second major step in expanding storage and retrieval services is to provide information immediately, with "turn-around" time in seconds rather than hours. This asset is inherent in mini-systems which are operated on location by those needing the information rather than a large computer center in batch mode with extended waiting periods. Remote time-sharing terminals also contribute to the solution of this problem.

The Classic All-Purpose Music Student Information Retrieval System was written as a model for the storage and retrieval of student information for a wide variety of uses. It was designed especially for the Department of Music at Arizona State University, which owns a DCC Classic minicomputer system. Simply stated, provision is made for the storage of any type and length of information for any student name. Ease of use and open-endedness were major prerequisites for this effort, allowing also for records of faculty as well as non-music students. Figure Two graphs the system's elements below.

Library Records. Books, recordings, journals, abstracts, and other hardcopy materials may be stored, indexed, cross referenced, and searched by key-word techniques to any extent and detail. Perhaps a reference to "The Instant Library" in the January, 1971 issue of Music Educators Journal is in order rather than to present the idea in detail again. In addition, two specific examples are reviewed below.

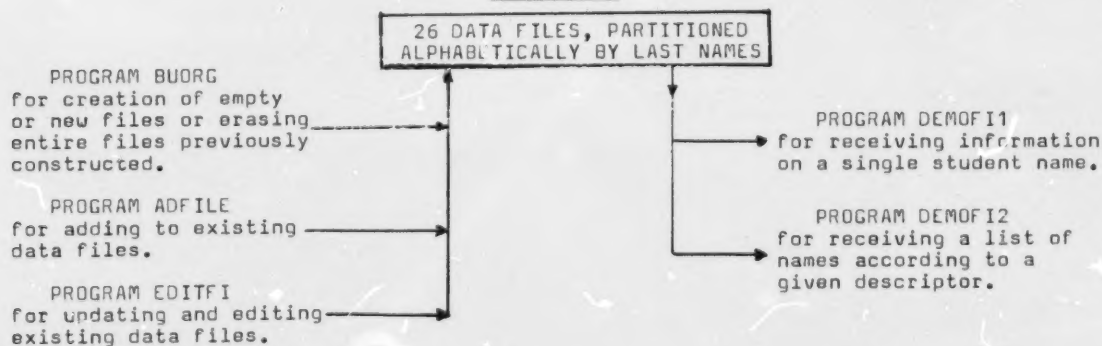
At Southern Methodist University, Dr. Charles Egle has just completed the Music Therapy Index under the auspices of and published by the National Association for Music Therapy, Inc. This work is a comprehensive index of

periodical literature pertaining to the influence of music on behavior. Containing 2,099 bibliographical entries, this index was computer organized and generated, based on keywords taken from titles of journal articles published internationally between 1960 and 1975. The Index is being made available in hardcopy format as a resource for music therapists, music psychologists, and music educators as well as psychological, sociological, physiological, and neurophysiological researchers. Librarians should find that the Index will simplify their task of locating and identifying the literature of music therapy.

SIRP (Slide Information Retrieval Package) was designed specifically for Dr. Glenn Williams of the Brigham Young University Department of Music, whose private collection of slides on musical subjects provides a vast amount of visual information to enhance his teaching of music history, literature, and musicology. A data file of slide information may be accessed for input or output by any number of programs written before or after the data file itself is completed. This provides for anticipated and non-anticipated data analysis and for the capability of format re-construction of the original data file. Information about each slide entry includes slide identification number, a broad category, a narrow category, and seven additional descriptors as desired. A list of slide ID's, then, may be obtained by OR logic (for example, all slides which contain either a trumpet or a trombone); or a much abbreviated list may be generated by AND logic (all slides which contain a trumpet and a trombone).

Scheduling. Scheduling may become very complex, especially in a department such as music where performing groups often duplicate personnel, last-minute arrangements of extra meetings are necessary, and an occasional lack of personal consideration for prior official clear-

Figure Two



ance results in conflicts in room, personnel, and time usage. Whenever clear communication between individuals in large departments is lacking, an even greater need is recognized for the usually simple task of disseminating information about scheduled events, changes of calendar, and day-to-day responsibilities.

Again, credit should be given to campus computer centers for becoming successfully involved in the scheduling of courses and in the registration of students. However, minicomputer use in scheduling within a school of music may provide, in addition to long-term and mammoth operations, constantly updated schedules which are quickly prepared and distributed, and "in-house" conflicts may be eliminated without lengthy human processes for avoiding such problems.

Through sophisticated programming, the storage of student and faculty schedules, room availability, and administrative requirements need only to be accomplished once in order to have clear student and faculty assignments in any format as well as to eliminate lengthy record keeping tasks.

Recruiting and Admission Processing. One major task in a successful recruiting operation is record keeping, and a large portion of the computer industry exists because of its superiority in this normally laborious chore. Names, addresses, evaluations of abilities and needs, personal contacts, inquiries, materials sent, and materials received all need careful attention to detail. In one major university, inquiry sheets are begun on each potential student who asks about the program. Through a rather elaborate scheme of folders, color codes, and check-off lists, a casual inquiry identifies a potential student, with his own individual folder whenever he responds with any completed form. This begins the process of evaluation for admission, with a check-off list of thirteen items sent to him (catalogs, flyers, etc.) and seven items which he submits.

Obviously, this particular school needs computer assistance for recruiting and admission processing less than most departments with less organized operations, but still the human effort could be greatly simplified by computer. And those departments with undefined recruiting practices may find that computer-organized procedures will contribute to refining their recruiting and admissions efforts. Related computer assistance is found also in mailing lists, semi-personal letters, statistical analysis of student background, alumni records and addresses, and newsletter organization and editing.

Cost Analysis. Universities are becoming increasingly cost conscious, and budget allocations are directly influenced by student credit-hour production. In addition to the "official" tabulation of cost as it relates to productivity, a more detailed breakdown of the music department operations is helpful. A continual check of budget situations could help avoid future deficits, the justification of priorities could be based on accurate data, and an "in-house" system could provide assurance that the figures handed down from the university administration were not only accurate but considered the unique expenditures and productivity of schools of music.

Other assistance may be found in comparative analyses between departments of the university and other similar institutions; in clear bookkeeping for scholarships, performing organizations, and gate receipts; and in long-term planning of budgetary needs.

Research for the Future. Budget analysis, when used to predict future needs, is an example already referenced for applying research techniques. Less obviously, curriculum trends could be analyzed and compared to other schools; and state, MENC, and NASM reports could more easily be prepared by the organized framework provided by the computer.

It is an established fact that minicomputers are relatively simple to operate and need no elaborate controlled environment. Short orientation sessions for all students and faculty would place the capabilities of the computer directly in their hands, and many would find that additional time spent in learning programming techniques would be invaluable in most facets of the academic world.

Teachers, musicians, and music department administrators often spend a great deal of time in non-academic and non-musical tasks which are necessary but frustrating when the time could best be spent where human interaction is necessary. Computer assistance could lighten the "paper work," with increased accuracy and with both anticipated and unanticipated values. These values, in turn, would be increased even more by freeing time for dealing directly with music and with students.

DATA BASE & DATA COMMUNICATIONS IN SCHOOL ADMINISTRATION

J. Richard Walker, Asst. Superintendent, Business Affairs
Jack Merrill, Director, Computer Division
Memphis City Schools

Data Base & Data Communications are being used in Memphis City Schools to solve some administrative problems common to large school systems. Data Base will ultimately make program maintenance less costly. Scheduling of films and audio visual equipment, and preparation of text for teachers' film catalogues are operating. Position Control is a useful tool in keeping the allocation of teachers and administrators in proportion to pupil population. Many student, personnel, and financial applications are being implemented and improved. Structured programming is being used to increase cost effectiveness of software production. A mixed vendor shop and several software packages help in getting operational efficiencies.

The present hardware consists of an IBM 370/135 with 256K of memory. There are five 3330-II type disk drives leased from Control Data Corporation (CDC), three IBM 3420 tape drives, and one remote and six local 3270 type terminals from Terminal Communication, Inc. (TCI).

The Memphis City School System started using computers in 1961. Financial applications were implemented first, and they still remain a substantial percentage of our computer applications. A double entry accounting system is used based on function and object codes for program cost. After each payroll and accounts payable run, we spend 30 seconds printing an updated balance sheet for investment and other financial control purposes. At month end, 50 different analysis reports are printed for financial accounting.

In payroll we print 25,000 checks per month and approximately 17,000 W-2's at year-end. Everyone wants their check on time and correctly calculated. When there are problems, the Payroll Section in the Division of Finance may quickly check the Payroll/Personnel records through the terminal. This is quite useful in keeping accurate payroll records.

Another use of the terminal is in the student attendance accounting area. When the Division of Records and Attendance needs to find which school a particular student is attending or what his attendance history has been, they can inquire to the student records maintained by

the computer and obtain the information very rapidly.

Additional terminal applications include film scheduling, personnel file inquiry and update, and inventory inquiry and supplemental issues update.

In the School Food Service area several reports are produced to assist in managing school cafeterias. These include cost of meals broken by labor and food. They also include the computer assisted nutrient system from U.S.D.A. which helps cafeteria managers in ordering proper amounts needed to prepare the nutritionally balanced meals planned. Our state claim for reimbursement is computerized. We do a free lunch analysis, a menu popularity, and a revenue register. In order to have monthly and year-to-date profit and loss statements, we take inventory of our schools monthly. The input is on Optical Mark Read Cards and is processed as a part of the cafeteria financial reports.

Inventories are kept in several different areas: textbooks in school, central warehouse items (maintenance, instructional materials, custodial supplies, and food items for School Food Service), and we print an inventory of equipment in school such as typewriters and film projectors.

Student activity accounting helps principals keep track of the monies receipted and issued in over 170 schools according to state law and accounting policies.

The Data Processing Division attempts to help schools by taking clerical type jobs off of both teachers and administrators. The Standardized Testing and the Report Card System are two other examples of this effort. Report Cards are printed for about half of our secondary schools with by-product reports which are very useful. In our standardized testing program, we test IQ in grades 3, 5, 8 and 10. Achievement tests are given in all grades, and we have started this year in Criterion Referenced Tests in the reading area. Input data is prepared as required by the State Department of Mental Health from our Division of Psychological Services. In student scheduling we use the IBM SSS/360 software for sectioning students into classes.

In our student records area there is a registration and student number assignment system. Scanner sheets are produced for the 20-day attendance reporting from which the Superintendent's Report is produced. The locator map based on street addresses is used in student assignment and boundary studies. Every 4 years we do a census of pre-school children by mailing out cards and having enumerators follow up on some of those that aren't returned.

In the personnel area, there are a number of reports that come from our personnel/payroll master. Lists of teachers who have requested transfers are printed in order to grant transfers in accordance with the rules and regulations. Notices are produced about when chest x-rays are due and overdue. Lists of substitute teachers, both certificated and non-certificated, are sent to principals periodically. Listings of employees by Job Code and Step and also by Location and Job Code are provided. Seniority reports are produced for use with unions and our educational association. Vacation reports control days of vacation. State sick leave days are stored. There are several applications relating to major medical insurance, and check writing in this application will start soon.

In our teacher assignment application we collect data on what subjects each teacher is teaching period by period and what their pupil load is each period. These assignments are then checked against the certification information, and reports are given on teachers who are teaching more than they should or out of their area of certification. This is both a useful administrative tool and results in an annual state preliminary report.

Position control provides good management information for important decisions in an area in which we spend a large part of

a 132 million budget. The principal has a large responsibility and he rightly seeks all the resources available to serve the needs of the students. Occasionally in the past some schools would be assigned more teachers than they were allotted. With position control these disparities are pinpointed, and a corrective assignment is made working with Personnel and the Area Assistant Superintendent.

The Data Processing Division routinely looks for better ways to perform various tasks both for the Data Processing Division and for the other groups in the school system that use the division services. We are, therefore, in a continual search for better methods. In the last few years, because of budget reductions, the number of employees has been reduced. At the same time that this reduction in force was taking place, an increase in reports useful to users has been produced. This has been possible, in part, because of the use of information processing techniques within our own area.

We buy software and hardware from the vendor who, in our judgement, gives us the greater mix of cheapest and best. The five 3330-II disk drives from CDC and the seven terminals from TCI cost considerably less than the same equipment from another well known vendor. There are times when vendors pass the buck to each other and we have to referee, but the savings are worth this trouble. We rent software from Westinghouse, IBM, and Software Design, Inc.

Structured programming is being used increasingly. This avoids debugging and upgrading in a "spaghetti bowl". Good programmers who plan and flow chart their work in advance and use meaningful names and adequate comments cards have used some of the techniques of structured programming all along. But somehow this has a way of getting lost after 10 or more revisions and improvements have been made.

In the fall of 1972 we decided to use data base. This was one of the most difficult and thoroughly debated policy decisions the division has faced since the decision a decade ago to acquire an IBM 360. The main motivation was to make changing and adding to files less costly in programming.

There are now ten files in DL/I format and 300 programs which work with them. Our largest DL/I effort to date was the development of the film scheduling system. This system also represents our most sophisticated terminal support. The following description of this system, therefore, might serve to illustrate our

approach to data base and data communications.

In the fall of 1974 computerized film scheduling was begun for the Division of Instructional Materials. An average of 560 films, with peak loads as high as 1500, are scheduled daily via a TCI 277 attached locally to an IBM 370/135. (There are five additional TCI 277's and one TCI 275 on-line simultaneously running various inquiry and data-entry applications.) The film records are stored on a DL/I film master file. This file is composed of a root segment which contains the title for each master film number, one print segment for each copy of the film in circulation, a description segment for each line of the film description, and subject segments denoting cross reference information.

Inquiry to the film master causes scheduling information for an entire school year to be displayed on the terminal. Scheduling for additional prints of the film can be displayed by depressing a specific key.

Films are requested by completing a pre-printed requisition form or by telephone. The master film number, school code, teacher name, use dates preferred, and the number of days desired are indicated. The person requesting the film is also encouraged to give "not before" and "not after" dates (a range of dates) marking acceptable alternative use dates.

This information is entered on the terminal and the least utilized copy of the desired master film number available on or nearest to the preferred date is booked for the number of days entered, plus one day for delivery, one for pickup, and one for cleaning and re-winding. The DL/I film master file is logged to disk for each film booking or extension. If none of the copies of a master are available within the given range of dates, the terminal operator is notified, and a rejection record is logged to the disk transaction file.

At the end of the day, this disk transaction file is used to print teachers' confirmation reports which tell them when to expect delivery of the film and when it must be returned. This report also informs the teacher if the desired film was unavailable within the specified range of dates. These records are sent to the teachers daily. The file is then merged onto a year-to-date transaction file and the disk space cleared for use during the next day's on-line scheduling. The year-to-date transaction file is used to print film delivery and pickup tickets and yearly utilization and rejection reports by school and by film. This

enables the Division of Instructional Materials to more effectively assign video equipment among the various schools and determine which films need more copies in circulation.

A film catalogue has been printed from the film master file. A tape copy of the DL/I film description and subject cross reference file was input to an RCA Photocomposer.

All changes, additions, and deletions (including damaged film handling) to the film master are presently in a batch job environment, but a feasibility study on providing on-line capability for these jobs is being done. All of the software for the film scheduling application was written entirely in-house.

In the spring of 1975 there were several requirements which forced a file change in the student master file. After much debate about how to handle this, the decision was made to convert the file and programs to DL/I. The system has been working well for more than a year.

Six people work on maintaining 1500 COBOL programs. The demand for their services could keep at least 12 people busy. The effort involved in converting to DL/I is adding to the work of the maintenance team. What is not so easy to determine is how much maintenance (and evolution of small improvements) is less costly because of the files and programs which now use data base. A comparison of the present structure of several major files with their original data base design indicates the flexibility is advantageous.

There are advantages and disadvantages to data base. The advantages of data base address the disadvantages of more conventional file to program to device relationships. For those who do not plan to invest much in conversion or program maintenance in the next two to three years, the data base advantages would be less significant. The Memphis schools justified data base in part on the basis of minimizing future conversion costs, regardless of whether they are caused by hardware changes or by systems improvements. The DP division was afraid that DOS/VS and data base would significantly degrade throughput through extra overhead and paging. These fears have not materialized. There is still much work to be done. All new files are being implemented in data base format, and the expectation is that all existing major files will ultimately be changed to DL/I.

KEY-TASK DATA BASE DESIGN FOR EDUCATIONAL USE

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This paper discusses bringing state-of-the-art strategy, namely, "key-task" data base management system (DBMS) design, to the educational field. Planning considerations include: data base structures, data base content, DBMS and administrative staff relationships, data gathering, conversion requirements, and structured programming design.

The key-task approach is used for the design of the data base as well as the file structures, including indexed sequential access mode (ISAM) files. The paper concludes with a step-by-step outline for the implementation of a practical data base management system for educational use.

I Introduction

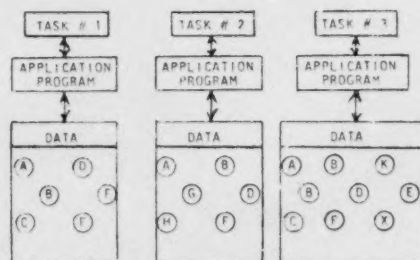
Data bases and data base management systems (DBMS) are here to stay, not only because our current technology can support them, but mainly because the overall cost in computer hardware, personnel, and management effectiveness is much lower than any other means of obtaining the same objectives. It is more than just cost, for the fact is that DBMS allows for management objectives which in the past have never been seriously considered simply because they could not be implemented.

DBMS is especially important in the field of education because it gives educators the power to work with students, parents, teachers, and administrators, as individuals. It is important to dwell on this for a moment because even though DBMS installations are judged by cost comparison, DBMS is not limited only to those applications which manage dollar sign data. The point is that DBMS can and will be applied to many more areas than current administrative/management uses. DBMS technology costs are coming down, a 16 bit parallel micro-processor chip is now available for under \$30.00! Educators will be able to apply DBMS techniques in many more areas to further humanize and individualize our educational systems.

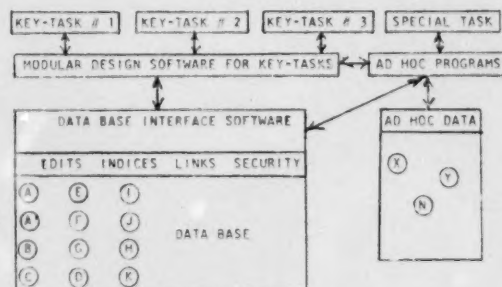
A comparison of traditional and key-task approaches to data management (see diagrams) shows data redundancy in the traditional approach as opposed to a minimum of redundancy in the key-task approach. Further, in the key-task DBMS

DATA MANAGEMENT DIAGRAMS

Traditional Approach to Data Management



Key-Task Data Base Management System



Note: (A) is the reverse format of (A)

all the data is available to any given task provided security allows that user

to access all the data. In a key-task DBMS, data inconsistencies are minimized and the same standards are enforced for each data type.

Data integrity can be maintained in the key-task DBMS because changes to the data base must be made through a common interface containing the appropriate edits. Responsibility for maintenance of given data types can be protected through the same interface. For many "ad hoc" programming situations (situations requiring a new input/output from the data base), all or part of the existing Modular Design Software may be reconfigured for the new task, thus preventing the usual long programming delays and high costs.

II Data Base Design

Data base design means the maintenance of all computer-readable data in a single pool or bank such that a computer program for virtually any feasible use may be run using this data base as input/output. It means that the data is stored in such a fashion that it is independent of any one program, although as a matter of fact, it may be used at this time by only one program. Good data base design also implies that the data and its relationships may be changed without engaging in a major programming effort and without changing other applications programs. This is called data independence.

Data base design does not mean zero redundancy as some have stated. There are applications where repetitive access to a type of data should have all or part of it stored in two places in order to prevent the necessity of a conversion processing operation each time it is accessed for one of two or more purposes. This might occur in a processing situation when processor time was at a premium. An example of this is a name and address printout where the name is also used for an alphabetic sort. In order to avoid the processing operation of reversing the name from sort to printout order, the name may be stored in the data base twice, once in normal order, and again, truncated, in sort order. The Data Base Interface Software would then update/delete both data base locations.

The problem is more complicated than that indicated above, and is also hardware dependent. Please note that the redundancy above was predicated not on data base considerations, but rather on hardware/scheduling limitations. Further, the redundancy was not by identical copy of the name, but the name in reverse order necessitating an additional processing operation. City/state and ZIP code data types may cause redundancy problems for many address data bases. There is no

simple answer to this problem, but is best determined before the DBMS is established.

Key-task design means that the data base is structured for greatest processing/storage efficiency based on the most important (key) processing operations. Importance includes the attributes of greatest cost benefit, longest job, most frequent processing task, and tasks with time constraints, such as payroll and scheduling. It means that the uses for a given piece of data must be spelled out. Data base storage file structures for the data type is based on cost of access versus processing under use conditions for given computing machinery. In most purchased generalized data base management systems, restructuring part or all of the data base and changing of key-tasks are possible. These are not considered as daily operations partly because of processing cost and partly because such changes must be transmitted to all personnel responsible for programming and maintenance.

Most commercial DBMS are configured for business applications, but are readily adapted to the educational environment. However, the costs of such a system, rental/hardware/storage, must be balanced against a much simpler, more to the point, in-house DBMS. Most educational data bases do not require all the "bells and whistles" which are needed to sell the generalized commercial version, but in-house programming costs must be balanced against additional hardware and leasing/purchase costs. The purchase or lease of a DBMS does not remove any of the planning steps for a successful DBMS implementation.

III Objectives and Administrative Staff Relationships

Objectives are important not only to point out the direction in which we are going, but more important in order to know when we have arrived where we were going in the first place! Without some sort of goals, the more specific the better, there is no test from which we can ascertain the progress of our efforts. This is not an attempt to force a specific management technique, for example, management-by-objectives, but rather an attempt right at the beginning to bring direction to our efforts. Objectives must come from somewhere, and how they are arrived at should be of some concern.

Before diving into DBMS as a data base solution, some management analysis or "front-end analysis" should be undertaken in order to determine that the solution, in this case DBMS, fits the problem. The point is that even the best DBMS will not

be effective where DBMS is not the complete solution to the problem.

DBMS implies a total organization effort, no department, no person is "left out." Whether administration has a top-down or bottom-up approach, it must include all personnel in discussions in the planning stage. Simply getting permission from the department head to proceed and letting the rest of the personnel scramble to keep up, is a gross misunderstanding of top-down management and will not produce an effective DBMS.

IV Data Base Structures

Three current data structures, relational, hierarchical, and network, should be mentioned. Hierarchical structures are historically the earliest and fit best in sequential processing, as was done when the majority of data storage was by tape media. IBM's Information Management System (IMS) uses hierarchical data structures. The hierarchical approach, especially for most educational data bases, is the easiest to implement by in-house personnel. As more sophisticated management tasks are placed on the system, the structures may then be changed to meet the new demands. Also, the Indexed Sequential Access Mode (ISAM), which is often used in the hierarchical approach, provides very fast single record access. In ISAM, records are accessed (read, written, deleted, and rewritten) through a hierarchy of indices according to a key within each record. This is very advantageous for on-line operations, especially for updating. The ISAM hierarchical structure models the real world hierarchical approach to data and while it is easy to conceive and institute, problems may arise in the searching and selection of specific data groups.

The network data structures follow the concept of "networks" in that all the data elements may be tied to (linked with) one another. Selection of like data items require traversing the various connecting chains. While selection procedures are greatly simplified, addition, deletion, and updating require changing of many links. These data structures are used in the system proposed by the Data Base Task Group (DBTG) of CODASYL.

Relational data structures are based on the mathematical theory of relations. While this provides a sound theoretical foundation, no large scale implementations of relational structures exist. In comparing the three structures, hierarchical and relational have explicit data relationships rather than by pointers as in network structures.

V Data Base Content and Data Gathering

The content, data elements (items), of the data base should be determined on their systems' need based on the key-tasks of the educational organization/unit. While space may be allocated for specific future expansion of the data base, it must be remembered that data entry as well as data storage and gathering costs money. There is no point to increasing the size of the storage medium if the data stored is not used. This goes further than just computer operations, even affecting management credibility. Regular practice of collecting data which is not used will produce unreliable data, for the persons responsible will know it is not used and will attend only to the production of the data and not its accuracy. If the data is not for immediate use, it must be at least edited and the edit results given to the data gatherers as feedback.

The data elements should be collected for low cost entry into the data base. Mark-sense reading and optical scanning need not mean the purchase of such expensive equipment, but often the source data can be read/scanned by a vendor if such arrangements have been made in advance so that the source forms fit their equipment and the procedure was determined cost effective. Some forms and formats are easier for keypunch operators to read and manipulate. Making their jobs easier will save data base money. All data elements should have a dollar value attached, for it costs to include them in the data base and it costs not to have them included when they are needed.

The data elements must be defined explicitly, and this is the purpose of the data dictionary. For example: state/country abbreviations must be spelled out as to number of letters, and which letters are to be used; they could also be looked up in a table of ZIP codes; etc.; data types must be decided upon and standardized. It is not sufficient to spell out the limits of each data element, but edits must be devised and written so that no extraneous bits may get into the data base.

Determination of the data base content should be begun from where the data last resides. This is also the point from which the DBMS should be designed. If begun at the beginning, where the data is collected, a crucial piece of data may be left out of the system, and a major portion of the system will have to be restructured in order to assure collection and maintenance of the data. To repeat, design and implementation of the DBMS is best done from the last data function to the first.

VI Structured Programming Design

Structured programming design may seem at first to concern only those who wish to

write their own DBMS. However, no matter how "total" a DBMS seems, there will always be that critical "ad hoc" program that must be written to get some essential piece of information from the data base. If the data cannot be gotten at in some "unplanned for manner" the DBMS is incomplete. The DBMS must allow for ad hoc programs!

For these programs and the DBMS, itself, modular structured programming should be used if some sense is to be made of the program in the future. While hardware costs are going down, programming costs are rising. The "job security" type of programming is not acceptable in today's market. Just as the data is spelled out in the data dictionary, so should the programming techniques and documentation procedures also be spelled out.

A top-down modular programming approach is recommended, that is, the highest level modules are coded first with each module containing its own I/O transfer to other modules, and each module designed to do only one specific job. "Stubs" can then be written to simulate lower level modules which have not as yet been programmed. As each module is added, a system test can be performed since it is a working system right from the beginning. The top-down approach eliminates the serious interface problems which can occur in the later design phases of the bottom-up approach.

VII Conversion and Conclusion

Conversion to the DBMS is ideally done in one big step after all the DBMS programs have been tested and run on a simulated and much smaller data base. This rarely comes about because the need is now, and so the DBMS is introduced a piece at a time, with the old programs and data banks still available. This may create some problems for keeping both sets of data up to date, but if the old programs and data banks were singular, this problem already exists. It is then a matter of which set of data to transfer to the DBMS.

It would seem desirable to have all the data correct before the conversion, but if you have lived with inaccuracies there is no reason that you have to suddenly stop and institute a massive correction effort. The conversion programs can just eliminate the edits for the actual transfer of the data, but use them for an error printout for correction of the data base as an on-going effort. New data, of course, will have to undergo the scrutiny of the edits. Hopefully, the DBMS will free some personnel so that error lists can be applied to the new DBMS.

DBMS is an exciting concept because it encourages us to think of huge masses of data as our really important and now totally manageable resource. DBMS forces

us to structure and rethink our management approach. It is also a time for experiment, allowing us to get almost immediate feedback in order to determine progress and to apply immediate corrections if necessary, to our educational programs, administrative reports/actions, and student/parent/teacher/staff needs. While DBMS is not the ultimate and only answer to all educational problems, it is a most flexible tool to provide a means for intelligent and human educational improvement.

VIII Outline for the implementation of a Practical Data Base Management System

- 1) Write management objectives for the educational unit(s).
- 2) Write all current data processing tasks, computer and manual, now being performed.
- 3) Write additional data processing tasks needed based on 1) minus 2), as well as from discussions with all affected people.
- 4) Determine key-tasks from total list of tasks.
- 5) Write detailed outputs required for key-tasks.
- 6) Prepare conceptual flows: list all inputs required for each key-task output.
- 7) List all data elements required for key-tasks.
- 8) Determine relationships among computer-stored data and produce the data dictionary (data base elements).
- 9) Determine data processing operations (flow charts) for key-tasks.
- 10) Determine User Language and DBMS language(s).
- 11) Specify data redundancies based on best processing efficiency and available data storage for existing computer installation (data storage structure).
- 12) Determine cost benefit for possible additional computer storage/processing hardware.
- 13) Determine conversion requirements from current data/operations to new DBMS.
- 14) Set up detailed plan for changeover to DBMS.
- 15) Determine edits required for data entry and data base structures.
- 16) Determine methods of backup, recovery, and analysis of the DBMS system activity.
- 17) Purchase/lease or write, then test DBMS and necessary ad hoc programs on simulated data base.
- 18) Convert to DBMS.

Note: A management feedback process is implied in all the above steps in order to insure continuity of the DBMS implementation and to insure data processing requirements of all personnel affected by the DBMS are kept current. The feedback is compared against the previous steps, always working back to step 1) so that the objectives are never lost from sight.

SMALL COLLEGE REAL TIME INFORMATION SYSTEM

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The development and implementation of an on line total information system for Ottawa University, Ottawa, Ks. and its branch college in Kansas City, Missouri. System utilizes a Data General C/300 Eclipse minicomputer with eight terminals dedicated to administrative functions; four terminals for communication to Kansas City; eight terminals dedicated to instructional computing and four to instructional functions on dialup lines. The paper deals with how the system was setup, its current status and its future. How a proper meld of administrative functions with instructional functions was achieved. Languages used: BASIC, COBOL, RPGII, FORTRAN. Operating systems: INFOS, CAM.

Through the auspices of a government grant received in 1975, Ottawa University established a computer center. The proposal was to design and implement a total data base management system over a three and one-half year period. Also, a part of the system would be devoted entirely to instructional computing, utilizing simulations and teaching of programming.

A committee of faculty and staff was established to investigate the various hardware configurations available within a budget limit of approximately \$140,000. After considerable deliberation, it was decided to purchase a Data General C/300 Eclipse Computer with 160-Kbytes main memory, a 800 BPI magnetic tape drive, a 600 l.p.m. printer, a 96 Megabyte disk drive, 4 hardcopy terminals, and 12 CRT terminals. The computer allows eight lines for multi-user BASIC, eight lines for administrative use in FORTRAN, and four lines for communication over telephone lines.

The main reason for the selection of the C/300 was the hardware map which would separate the administrative data base partition from the instructional partition. This hardware map is an additional protection for the administrative data base from access by students utilizing the instructional programs.

Systems development began in the fall of 1975 and was done in consultation with the Computer Users Committee, made up of faculty and staff members. The first step in system development was to determine the system currently being used on a

manual basis. A survey was done at each of the major administrative offices: Admissions, Registrar, Dean of Students, Financial Aid, Alumni/Development, and Business Office. During the course of the survey, the data elements used by each office were determined and the master data base was developed.

In developing the master data base, no limit on type or amount of data was enforced. Thus, each office was able to put into the data base all data used and all data it would like to use. Once the total data base was defined, a data flow system was developed for each office along with appropriate forms and reports.

A six digit alphanumeric number was assigned to all individuals, students, prospective students, faculty, staff, and alumni. The first two digits of the number indicates the year of entry and the last four are alpha-sequence. This facilitates sorts and keeps key length to a minimum, thus speeding up access time in either BASIC or INFOS.

When the computer was delivered in late March, 1976, the system had been completed through Admissions and Registration. It was decided to develop each module of the total system separately so that each office could begin handling their own files as rapidly as possible. To this end, the initial programming was done in BASIC. By using this approach, it was possible to bring up the Admissions Office, Registrar, and Dean of Students Office as separate modules for file maintenance. Reports were programmed in

RPG II. At the same time overall systems development and programming proceeded in INFOS with FORTRAN interface utilizing CAM (Communications Access Manager). The development of the total data base management systems lagged behind the initial BASIC system by design and the growth of the Ottawa branch college in Kansas City. Since the College Without Campus (C.W.C.) was a relatively new venture, it was decided to do the complete information system for C.W.C. first and use it as a test ground for the entire system before installing it on the main campus. Also, C.W.C. was growing so rapidly that an immediate and complete system was needed. Current enrollment is 1750 students.

Two terminals were installed at C.W.C., a CRT and an IBM communications typewriter. The CRT is used for display and on-line record modification. The communications typewriter is used for batch processing of new records and financial transactions. A dedicated line on the Kansas City exchange was purchased to handle the phone traffic.

In September of 1976, the first on-line registration was held utilizing the Registrar's, Dean of Students', and Admissions' modules. Average access time was under five seconds for each of four CRT terminals used at registration. Pre-enrollment data and basic student census data was entered into the system prior to registration. Each student sat down so he could see the CRT as he went through registration. Thus, the student could see the data that was being kept on his record.

As of February 1, 1977, the following modules were in the system:

- 1). Admissions Office: Complete on-line file maintenance. All reports and all mailing labels being printed on schedule.
- 2). Registrar's Office: Complete on-line file maintenance. All reports, grade slips and permanent records being printed.
- 3). Dean of Students: Complete on-line file maintenance. All reports and mailing labels relative to census type information being printed.
- 4). Alumni/Development: On line file maintenance of census data. Mailing labels and status reports being printed.
- 5). College Without Campus: On line file maintenance of all records. Reports and mailing labels being printed.

The system will further advance with payroll accounting going on by February 28, 1977, both at C.W.C. and the main campus.

By the fall of 1977, all student accounting functions will be in the system as

will all gifts accounting for the Development Office.

Following is the detail for the Admissions module (AMIS-Admissions Information System). All other modules follow the same basic pattern.

The "AMIS" system was created to provide on-line information input and retrieval. All programs, subprograms, and files are written in or accessed in BASIC. Records are 1024 bytes long (1023 datum + 1null). The hardware system was designed around a Data General Eclipse C/300 computer, 90 Megabyte disk, and CRT terminal. Maximum core requirements for driver program are 10 Kbytes, maximum file sizes are determined only by available disk storage. The "AMIS" system consists of the following:

- AMIS.PG-Main driver program
- AMIS.LG-Log program to provide audit trail
- AMISSORT.PG-Subprogram called in by driver program to handle indexed sorts
- AMISCODE.PG-Utility program to add/update code files
- AMISDUMP.PG-Utility program to access files for individual auditing and trouble-shooting
- AMIS.FL-Data file used to hold explanatory data and instructions
- AMIS.IN-Data file containing information of each data item of the data base record
- AMIS.VL-Data file containing the total record of the prospective student
- AMIS.CT-Counter file storing file counts
- AMIS1.IX-Index file containing student ID and volume record number
- AMIS2.IX-index file containing student ID, student name, and volume record number
- AMISn.CD-Various code files: n=number of the file
- PAGE.n-Various subprograms of page formatted data: n=number of the page
- ITEM.n-Various subprograms of item entry: n=number of the data item to be corrected or entered

AMIS.PG is the main driver program for the "AMIS" system. The program is under 10 Kbytes and works with a number of subprograms by swapping them in and out of a core work area.

The program opens and updates 8 data files, and terminates each record entry or update with a data file update (i.e., bubble sort). AMIS.PG will enable a generic search to take place by name or a substring of a name utilizing index file AMIS2.IX then displaying any keys matching the given specifier.

After a generic search of the name, thereby giving another dimension of protection against duplicate records, AMIS.PG allows

a specific search to take place using the STU-ID number and checking it against the index file AMIS1.IX.

In the event that no record matching the given specifiers is found in either of the two index files, a prompt is given as to whether to create a record for this specifier or terminate search.

The driver enables the system to remain totally self-sustaining, thus only that data required in batch for reports need be intervening. In the event of system crash, it is necessary to immediately audit the files to ascertain whether or not they sustained any loss of integrity. The driver program uses data file AMIS.IN to handle explanatory data, coupled with READ/DATA statements to reduce program queue.

AMIS.LG is the system log. It is a 1024 byte record (1023 datum + 1 null) containing the record as it existed at the time it is first accessed and the record as it appears after the last data entry. During both entries into the log, the current date and time are logged into bytes 1012:1023.

AMISSORT.PG is a subprogram called at the termination of data entry in program AMIS.PG and handles the sorts for index files AMIS1.IX and AMIS2.IX, and the update for counter file AMIS.CT.

The maximum size required for the subprogram is not over an additional 1.5 Kbytes. AMISSORT.PG is swapped into the lower core work area of the driver program while it performs its file maintenance, using bubble sort technique.

AMISCODE.PG is a utility program used to update the various code files that are used in the "AMIS" system. There are eleven (11) different code files used, and each may be accessed by the utility program and sequentially appended to.

AMISDUMP.PG is a utility program designed to help audit and troubleshoot data files used in the "AMIS" system. The program could be used with other data files as well.

Prompts are given to the operator requesting the filename, record size, number of lines desired to be output per record, the starting and ending byte numbers, and whether to output to the line printer or the terminal.

```
FILENAME:      MYFILE
REC LENGTH:    256
LINES/REC:     2
FROM:          1 TO: 6
FROM:          7 TO: 28
OUTPUT TO $TTY OR $LPT?: $TTY
```

Listing of each record of the file MYFILE will be printed in two lines having the data designated. Automatically closes files after sequentially reading the last record.

AMIS.FL is a data file that is used solely for reference and information purposes. It contains most of the program description and explanation, thereby saving space in the driver program.

AMIS.IN is a data file which is referenced by the main driver program. It is composed of 128 byte records (127 datum + 1 null), each record containing information about the item in the data base with which it corresponds.

EX: ITEM.01 = REC # 1

EX: ITEM.02 = REC # 2

AMIS.VL is the volume data file of the "AMIS" system. It contains the total record (1024 bytes = 1023 datum + 1 null). Records are entered sequentially as they are created, and the volume record number "tagged" on the end of the corresponding index record found out in the index file AMIS1.IX.

Records are not physically deleted from this file until the following academic year at which time all the files are reorganized. There is, however, a delete indicator which sets a flag on the record showing that it should be ignored for accounting purposes. Thus the file maintains its integrity, never having to shift and sort itself; other maintenance being taken care in the other files.

AMIS.VL should not be confused with those INFOS files having the same extension. This is a "BASIC" file, accessed by the index file AMIS1.IX.

AMIS.CT is a data file used solely for the purpose of keeping track of the number of records moving around in the various data files. It is updated in a number of cycles, one coming from the driver program, another coming as a result of the file maintenance initiated by the subprogram AMISSORT.PG, and a third coming as a result of the subprogram ITEM.02. All data in this file is numeric is four byte records.

The file records should show the following:

```
rec 0-number of records in index file
      AMIS1.IX after data entry
rec 1-number of records in index file
      AMIS1.IX before data entry
rec 2-next record number in volume file
      AMIS.VL
rec 3-number of records in index file
      AMIS2.IX after data entry
rec 4-number of records in index file
```

AMIS2.IX before data entry
rec 5-volume record number of the last
or immediate record initialized

AMIS1.IX is the index file consisting of eleven (11) byte records: 6 STU-ID + 4 numeric + 1 null. Data file is used in conjunction with binary search to locate STU-ID and volume record number. The volume record number allows random access of the volume file for the desired record.

AMIS2.IX is the index file consisting of thirty-three (33) byte records: 6 STU-ID + 22 alphabetic + 4 numeric + 1 null. Data file is used for generic search for existing records, thereby lessening duplicate record creations.

The AMISn.CD files are the code files. Each file is 64 bytes long: 63 alphanumeric + 1 null. Data files are accessed by both driver program and various subprograms. Coded data files may be sequentially updated by the utility program AMISCODE.PG and sorted on the INFOS SORT/MERGE.

The following are the presently available files:

- AMIS1.CD-Special talent
- AMIS2.CD-Names of college representatives
- AMIS3.CD-Religious affiliations
- AMIS4.CD-Source code
- AMIS5.CD-No-show codes
- AMIS6.CD-Decision factor codes
- AMIS7.CD-Race/Ethnic
- AMIS8.CD-Marital status
- AMIS9.CD-Number of dependents
- AMIS10.CD-Materials sent
- AMIS11.CD-Contacts

PAGE.n is a general designation of the series of "PAGE" subprograms used by the driver to display formatted data of a current record on the \$TTY.

Each subprogram is called into the lower core work area by the driver program. "n" evaluates to the "PAGE" extension found on end of each "PAGE" subprogram. At present "n" will evaluate to 1 through 11 inclusive. (i.e., PAGE.01 through PAGE.11)

The item subprograms handle the various data input and alterations. They are called in by the driver program to the lower core work area, none of which require over 1 Kbytes additional core.

At present, there are 77 different "ITEM" subprograms, numbering from: ITEM.01 through ITEM.77 inclusive. Each of these subprograms handles a different data item, from the "AMIS" data base.

THE M.I.S. NEEDS OF A REGIONAL MENTAL HEALTH INSTITUTION

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This paper reports the results of an M.I.S. needs assessment conducted by the authors for a regional mental health facility. The facility incorporated both flexible scheduling and off-site collaborative services. The procedures used and results of the needs assessment are described. The general design of a management information system which is sufficiently flexible as to meet the needs of such a facility is also described.

The management information needs of a social service facility are essentially two dimensional. One dimension is the management of the institution's finances. Many M.I.S. systems currently in existence concern themselves with the finance dimension (Enger, N.L., 1969; McDonnell Automation Company, 1968; Sayles and Chandler, 1971; Smith and Sorensen, 1974). A second dimension of need concerns pupil tracking, placement, and the assignment of resources to clients as to maximize both the cost effectiveness of the institution and the benefit to the client. This second dimension has not been explored in depth. A search of the literature indicates that a management information system which satisfies the second dimension has not, up to this point, been developed. The operational objectives which such a system must satisfy and the parameters within which the system would be designed have not been well defined.

In October of 1976 the Laboratory for Statistical and Policy Research at Boston College was contracted to develop a management information system for the Hogan Regional Mental Health Center in Danvers, Massachusetts. The global objective of this system was to supply both pupil tracking and placement information. The procedure used to develop the major objectives for the system and the operational character of the system has been successful in many social science research and educational applications. The needs assessment was performed using the interview format (Adkins, 1974; Coleman and Karweit, 1972). The design of the data files and system subroutine interface also followed procedures well known in the social sciences (Damrose and Marks, 1976; Nie, et. al., 1975). User input was to be essentially

in standard English. All of the interfacing between the various subroutines was to be executed under program control without user intervention.

The procedures used to determine the M.I.S. needs will be described. The system's objectives and the constraints necessary for a M.I.S. system which is designed to be client orientated will be discussed in detail.

The procedure used to assess the M.I.S. needs of the Hogan center was of the iterative interview type. The Assistant Superintendent of the center was interviewed first and he helped to familiarize the M.I.S. staff with client curriculum and program planning. At this first interview, tentative output documents were devised. It was decided that four basic areas consisting of general Census information, Program information, Scheduling information, and a Transportation schedule needed attention in order to accurately and completely delineate a client's file.

Census information includes general information on a client such as a name, address, various identification numbers, and abilities and skills. At a glance an employee is able to find important information about the person they are working with. A large quantity of census information can be printed out in relatively little space, saving time in searching through files or lengthy reports to find a small but essential piece of information.

Program information lists the service programs, the client needs, the hours needed compared with the hours provided, and the ratio of instructor to client(s) required compared to the ratio provided. Program

information will allow the compilation of aggregate reports containing information which will be helpful in determining management decisions concerning the improvements of institution efficiency and effectiveness.

Scheduling information is a day to day, hour to hour detailed schedule of the client's activities and appointments making possible contact with the client at any time. The dynamic nature of a mental health facility requires that accurate information is maintained concerning the location of students. Since the institution reflects client needs a particular client's schedule may change periodically. The degree of flux inherent in this type of institution could easily lead to the scheduling of a student to more than one treatment modality or many instructors to a student at some particular time. In order to insure that this does not occur, accurate and timely scheduling information is necessary.

The transportation part of a client's record gives a schedule of when, where, and by whom the client is transported throughout the day. This is necessary since some service programs are provided at other health centers. In addition, many clients are not residents and thus need daily transportation between their place of residence and the health facility. Transportation reports will not only be used by the health institution but also by various transportation companies contracted by the institution. No transportation company will receive any personal client information. A special report including only names, addresses, and specific time schedules will be given to the company.

These documents, visualizing the output design of the four areas of needed information just discussed, were used as starting points for the second set of interviews with upper level administrative personnel. After each interview the output documents were modified to reflect the needs of the person interviewed. The updated documents served as input documents to the next interview. It was important that no necessary information was overlooked.

Programming and system design personnel were involved with the interviewing task. This practice assured that the personnel involved with the designing of the system were well aware of the needs and system objectives. In addition to the initial output documents, the nature of the institution was revealed in these interviews. This knowledge helped assure continuity between program and system design and the facility's needs.

The Hogan facility, like most other mental

health institutions, utilizes many of the complimentary services offered by the community. Clients may be at any of a number of different facilities during the course of a normal day. They may be transported by one of many transportation companies. The mode of transport to an ancillary facility may not necessarily be the mode of return to the center. Clients may be involved in a number of different activities at hours not similar to those found in a normal blocked schedule (Coleman and Karweit, 1972; Jenson, Burr, Cofield, and Neagley, 1967). Classes may be scheduled into fifteen minute or six hour blocks. The same classes may or may not meet on all days. The schedule cannot be blocked.

The program for a particular client may change at any point in time. Although the client's program may change frequently, accurate records are often demanded with little advanced notice by various federal and state regulatory agencies. These constraints and the dynamic nature of the institution resulted in the following nine objectives for system operation. Each of these objectives will be described in the following paragraphs.

1. The information contained on an individual client record must be able to be changed at any time and 2. Aggregate reports must be obtainable. The dimensions or categories of aggregation and cross-tabulation are not fixed and may change from time to time. These two objectives were briefly dealt with above. It may be added that when a client's record is changed it is important that this change is recorded accurately and distributed to all personnel who need this information.

Previous to the system, a change may have been known to an employee working directly with the client but otherwise was left unrecognized throughout the institution. This causes problems with correctly compiling various aggregate reports. It should also be mentioned that certain reports may be asked for on a routine basis and a standard form for these can be devised and included in permanent subroutine programs. The system must also be capable of handling additional subroutines containing a variety of formats. This degree of flexibility implies that fixed formatting, fixed variable definitions, and fixed length data files are inadequate for this system.

3. The system must have the capability of adding new variables, and new values to old variables. Though it is hoped that all of the necessary information on a client was included in the first compilation of data it is certainly unrealistic to suppose that new conditions, redefinitions, or changes in the nature of the facility would not call for an expansion

of the system in the way of a new variable or new value to an old variable. Allowing the system this basic flexibility expands its capabilities and use.

4. All information distributed to the user should be in non-coded form. It is important that output is easily interpreted without the use of lengthy code-books, and usable to anyone who needs information on a client. Language, which the institutional staff is familiar with should be used. Thus, the importance of system design personnel being involved in the interview process is reflected here. Through their interviewing, they were able to become familiar with common usage and standard abbreviations used by the facility's personnel.

5. The minimum amount of non-coded information can be maintained on the client's record. Not only is this the most efficient and least expensive method of storing information but it also lends itself to the problem of security which is discussed in connection with the following objective.

6. All possible precautions must be taken to insure that if a listing of the client records and the variable library is obtained the minimum amount of information can be decoded. Confidentiality is important at most all such institutions and thus the question of security was raised and provided for in the system. Because variables are identified by code numbers, a listing of the resource record will not allow the potential unauthorized user to gain vital information on a client. It is necessary to maintain a dictionary of variable and value names which are kept in a variable library. This library is to be written on every input and/or output tape which will be in the possession of a member of the Hogan facility except when in use. While the program is being used this library will be transferred from the input tape to a system's disk file in binary format. Thus, no readable output can be obtained and the disk file is destroyed upon program termination.

7. All efforts should be taken to insure that upon the abnormal termination of a job all modifications made, up to that point, are transferred to a new file. Many modifications may be made at one time. Card or terminal input will be used to make these changes. It is probable that a mistake could be made on an input card. It would be inefficient if no modifications, after an unrecognized card is read, could be made. Thus, until a mispunched card is read, all modifications will be recorded on output files. In addition, an error message will indicate exactly where the system ceased to make modifications.

8. The source module must be portable. It

should be as system independent as possible. Because of security, input and output tapes will be maintained at the facility and transferred to the computer facility being used when necessary. Many computers are available to the administrators of a public health institution. A portable source module will allow the administrator to choose the hardware system which will be cost effective. The source module and all subsystems should not be written in any machine dependent language.

9. The management information system must be accessible by the most unsophisticated user such as a low level clerk or secretary. Access to the system should not require the use of any language other than standard English. Modifications which need to be made such as updating a client's record are most likely to be accomplished if the procedure is easily understood. Using language familiar to the user and simple input formats is the simplest method of handling this. If the user wished to update a client's record the required keywords should be similar to "change client record" or some nomenclature equally as basic. In order to maximize the system's cost effectiveness, access should be able to be made by a clerical level employee. The greater the ease with which the system can be utilized, the more it will be used. The greater the degree to which the system is used by management level personnel, the more effective the facility will become in meeting client needs.

In summary, two general areas have been discussed. The first was the procedure used to assess the M.I.S. needs. The second was the needs themselves. The assessment of M.I.S. needs requires the direct involvement of system's design personnel and facility personnel. The interface of system design personnel with the user insures that the system will maximally satisfy user needs.

The M.I.S. needs of a mental health facility are in many ways similar to the needs of other institutions. Accurate aggregation of client and provider services are required in order to maintain the institution's cost effective posture and to insure that client's needs are met. The M.I.S. requirements of a mental health facility is in many instances somewhat different from the needs of other institutions. The sensitivity of client data increases the complexity of the system. The lack of an in-house computer requires that the system source module is portable.

References

- Adkins, D.C. Test Construction, 2nd. ed., Columbus, Ohio: Charles E. Merrill Publishing Co., 1974.
- Coleman, J.S. and Karweit, N.L. Information Systems and Performance Measures in Schools. New Jersey: Educational Technology Publications, 1972.
- Damrose, C. and Marks, G.A. Osiris III, Volume 6: Primer. Univ. of Michigan: ISR, 1976.
- Enger, Norman L. Putting M.I.S. to Work. Amer. Management Assoc., 1969.
- Jenson, T.J. Burr, B.B. Coffield, W.H. and Neagley, R.L. Elementary School Administration, 2nd. ed. Boston: Allyn and Bacon, 1967.
- McDonnell Automation Company. Total Information Processing System Requirements. Missouri: Division of Mental Diseases, 1968.
- Nie, N.H. et. al. SPSS: STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES. New York: McGraw-Hill, 1975.
- Sayles, Leonard R. and Chandler, M.K. Managing Large Systems Organizations for the Future. New York: Harper & Row, 1971.
- Smith, T.S. and Sorensen, J.E. Integrated Management Information Systems for Community Mental Health Centers. Rockville, Maryland: National Institute of Mental Health, 1974.

GENERAL INTEREST

CERTIFICATION OF EDP EMPLOYEES
BY THEIR TEACHERS

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The problems associated with proposals to certify or license data processing practitioners suggest that either professional organizations or a state agency may lack the time, expertise or public confidence desired. This alternate plan includes established career paths together with prescribed competencies for each EDP job or task. Instruction and training is to be conducted by certified EDP instructors who certify the level of competency observed for each practitioner. After receiving the required job certification, a series of standardized examinations would allow the practitioner to advance to the next higher level in his career path. An employee's personal record of certification will always attest to his qualifications and competence for employment or promotion.

The objective of this paper is to suggest a role for professional EDP educators that will prepare EDP practitioners for either certification or licensure as well as verification of skills and abilities for employment. Specifically, this plan will require EDP teachers to certify that a practitioner has met the group of competencies required for any data processing job classification. A hierarchy of job classifications makes progressive certification a desirable possibility for both employees and employers. The certification may be entered upon a practitioner's personal certification record form as well as on a master record maintained by one of the professional EDP organizations. Practitioners could use their personal records of certification for employment interviews, and the master records would be available for verification of employment interviews or for promotion eligibility.

The current debate among professional EDP societies and practitioners concerning the alternatives of licensure or certification seems to focus upon the problems related to verifying the competency of EDP practitioners. Despite the advantages associated with either licensing or certifying procedures, the real need seems to be a method by which employers, clients, and the public may have confidence in the competency of the professional EDP practitioner. Of course, ethical conduct is an implied requirement for retaining an EDP license or certificate, but this article deals only with a feasible method for certifying individual competence.

Many EDP job classifications lend themselves to a hierarchy of competencies. For example, a list of competencies for a computer programmer appears in Table I. Although individuals may have slight disagreements with the specific competencies for any job classification, the data processing industry has the professional machinery for obtaining agreement and standardization. For example, representatives from the professional EDP societies, employers and EDP practitioners could constitute a task force to develop a list of work competencies required for adequate performance on any EDP job. Yeoman effort in this area has been performed by Mr. Raymond M. Berger, author of the AFIPS publication, Computer Programmer Job Analysis Reference Text.¹ This publication is the result of substantial work by Mr. Berger and a committee directed by Mr. Donn Parker. The Weber list of EDP position descriptions² and Mr. Berger's book provide a valuable beginning.

¹Berger, Raymond M., Computer Programmer Job Analysis Reference Text, 3rd Printing, AFIPS, Montvale, NJ, May 1975.

²Hansen and Philip H. Weber, Weber Position Descriptions For Data Processing Personnel, 1975, p. 7.

TABLE I²COMPETENCIES REQUIRED FOR EMPLOYMENT
AS AN APPLICATIONS PROGRAMMERAPPLICATIONS PROGRAMMER--A
(Reporting to EDP Manager)

Conducts detailed systems analyses
Writes systems definitions
Develops block diagrams
Develops machine-logic flow charts
Prepares test data
Writes program code
Debugs programs
Tests programs
Revises programs
Modifies programs
Documents computer procedures
Evaluates programs

The usefulness of job competencies is well understood by educators who have often used lists of competencies for constructing academic course outlines and academic programs. This proposal would allow EDP instructors to certify each EDP competency after the completion of instruction, examination, and performance tests. Of course, different competencies would require different methods for demonstrating proficiency. So long as the methods for demonstrating or meeting a competency are standardized, the responsibility for certifying competence rests with the EDP instructor. Therefore, competencies could be certified by vocation schools, community colleges, 4-year colleges, or by in-service training at the practitioner's place of employment. An example of the requirements for meeting competency is shown in Table II.

TABLE II

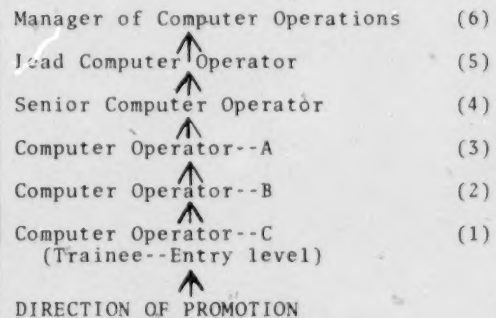
POSITION: Applications Programmer--A
COMPETENCY 1: Writes Program Code
REQUIREMENTS

Write COBOL code without errors
A. Write Identification Division
B. Write Environment Division
C. Write Data Division
D. Write Procedure Division
File usage instructions
Input/output instructions
Assignment instructions
Control transfer instructions
Looping instructions
Data modification instructions
Use external subroutines

EDP employees and students will find the competency plan prescribes exactly the requirements for entry-level employment or promotion. Some competencies could be met by performing different tasks to the satisfaction of a certified instructor; therefore, many EDP employees with practical experience could proceed through the progression of competency certifications without classroom instruction by a certified EDP instructor followed by minimal performance on a written examination. The standardization of EDP competencies would encourage employees to continue their education and training, since there would be confidence that additional certification could not only result in a promotion with the present employer, but the additional competency could also make the employee more employable in a competitive job market.

The effectiveness of this EDP competency proposal depends, in part, upon a set of standardized career paths that provide hierarchies of jobs. Promotion or employment into any job position would require certification that all competencies have been met for the new job as well as for all lower-level jobs. A typical career path progressing through several job positions is illustrated in Table III.

TABLE III

CAREER PATH
(Hierarchy of Job Positions)

The career path in the example illustrated in Table III begins with the Computer Operator--A job classification, and promotion is upward to the Manager of Computer Operations position. A beginner would need all the competencies listed for the Computer Operator--A position before being employed. Promotion to the next higher position could not occur until that position's competencies have been met. Of course, a new, experienced EDP employee could be hired into this career path at

any position, provided he had been certified as having met all the competencies for the position. This plan provides for all new EDP employees to complete a minimal amount of instruction and certification before employment at the Computer Operator--A (trainee) level. However, there is little serious objection to allowing new employees to work as apprentices for a limited period. A new uncertified employee would still enter the career path at the lowest job level; and uncertified employees would be allowed 6 months in which to become certified as a Computer Operator--A.

A brief example may clarify the way this certified competency plan would work. Joe Smith, an 18-year old high school graduate, asks how he can get a data processing job. Joe is shown a list of EDP jobs in the career path similar to the list in Table III or in Table IV. Each job also has a set of competencies that must be met before employment can begin at that level. Joe must meet all the competencies required for the entry level job, Computer Operator--A (trainee), before he can be considered for employment. Joe would probably attend a data processing school; and upon successful completion of the prescribed courses, Joe's instructors would certify his level of competence. Such a certification would show the instructor's name and the grade alongside each competency on Joe's certification record. After initial employment Joe could prepare for the standardized certification examination by completing additional courses or by demonstrating his ability to perform tasks. It is expected that promotion would be withheld until Joe passed the certification examination. In all cases, certification would be by EDP instructors.

Progress upward through the certification hierarchy is intended to reward those who aspire to positions with higher salaries and greater responsibilities. At the same time the system can accommodate those who prefer to deliver a high quality performance in one job without seeking advancement. Table IV shows the relative location of the various standardized certification examinations and the job classification immediately available after an examination has been passed. Table IV shows that all employees begin as a Computer Operator--A (trainee) and proceed to the Data Processor I Examination. Although there are several other job classifications possible without completing the Data Processor I Examination, no employee can become a Programmer Analyst without completing the Data Processor I Examination.

The certification progression illustrated in Table IV shows that all data processing practitioners must pass both the Data Processor I Examination and the

Advanced EDP Examination II before selecting one of the four areas of specialization. The areas of specialization are: (1) DP Management, (2) Management Information Systems, (3) EDP Instruction and (4) Systems Programming. Table IV merely identifies the major standardized certification examinations along with their relative positions in the career paths. A number of EDP jobs are available regardless of whether the standardized certification examinations have been passed.

The obvious implication of this proposal is that competence throughout the industry would be maintained by EDP instructors. Certification would be by formal examination only after completion of instruction and tests supervised by qualified EDP instructors. The education profession has considerable experience in certifying competence; therefore, this responsibility would not present any unusual demands upon EDP faculty members.

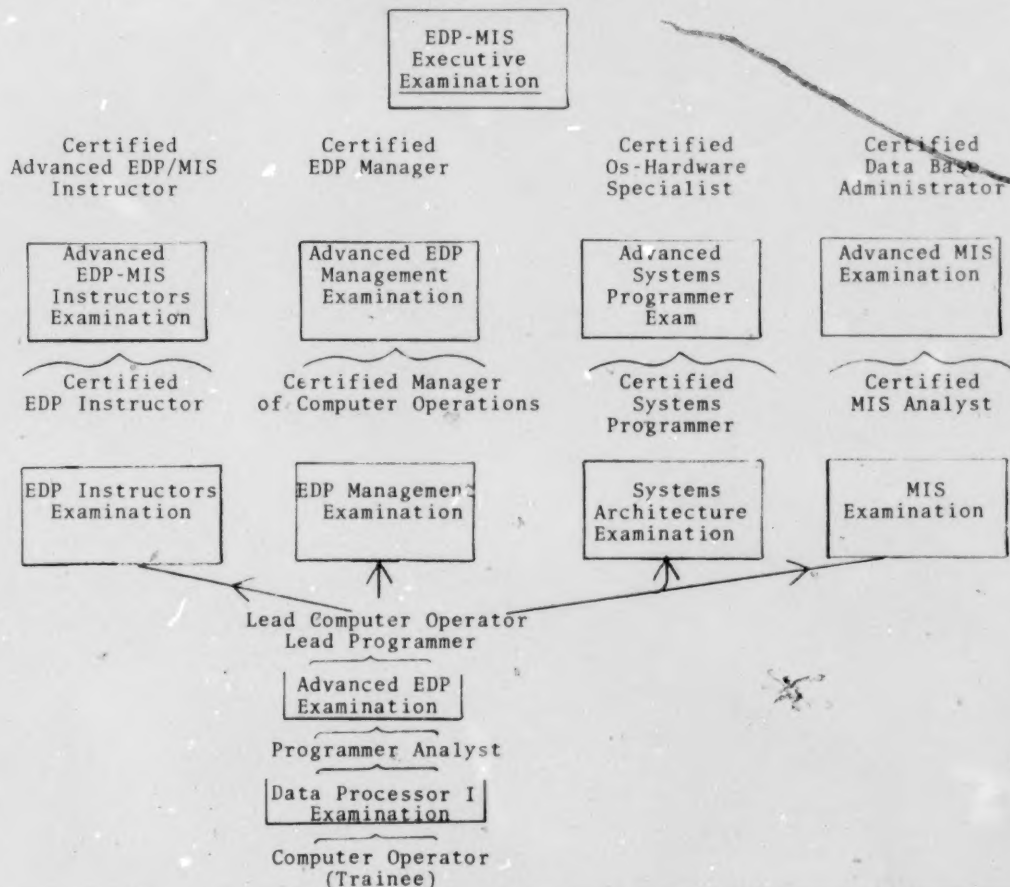
An additional implication of this system includes the certification of EDP instructors. Although some schools employ teachers that meet educational certification requirements, there seems to be little effort to certify or verify instructors' EDP competency. Some states have established minimal academic credit requirements for teaching EDP subjects. However, there is little evidence that even these mandatory academic requirements are being enforced. A few schools employ EDP instructors that are well qualified both academically and technologically. But it appears that far too many EDP classes are currently being conducted by individuals who are not qualified.

Several distinct disciplines seem to characterize the areas in which an EDP instructor should be qualified. These areas are: (1) EDP technology and (2) the teaching of EDP concepts. There are also related areas that may complement the qualifications of any EDP teachers; and these additional qualifications would allow the teacher to specialize in a type of EDP application. For example, those instructors teaching business EDP applications clearly need competence in: (1) EDP technology, (2) EDP teaching principles and (3) business practice and procedures. Similar specialization is appropriate for instructors teaching scientific, medical, governmental and research EDP applications.

The general procedure for certifying EDP instructors includes the same basic steps required for all practitioners in the profession. Instructors could be certified at different levels, but no instructor could teach beyond his level of certification. Certification to teach at any level would require having been certified as an EDP practitioner at that level as well as

TABLE IV
EDP CERTIFICATION SYSTEM

Certified
*V.P. of Data Processing
*V.P. for Information Systems
*EDP Education Director



at all subordinate levels. The illustration in Table IV may help clarify the relationship between the certification of EDP practitioner and EDP instructors.

The existence of a formal certification procedure is desirable in order to provide a continuous assurance of competency. Certification probably will not guarantee absolute perfection by all certified data processors, but the system can accommodate a variety of controls to assure quality. Two questions suggest problems encountered by other professional groups.

1. Should certified data processors be required to complete refresher courses within specific time periods in order to retain their certification?
2. Should certified data processors who have not actively practiced their profession for 5 years or longer be required to renew their certification by refresher courses?

A responsible answer to these two questions can also be used to support this proposal. Even though some of us may feel the sting of the certification lash, our clients and our public will be better served because of our penance.

HUMAN VALUES IN EDUCATIONAL DATA SYSTEMS

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Perhaps the most sophisticated tool mankind has yet developed is the computer. This "tool", however, has often been misused and man made to serve the tool rather than vice versa. The paper attempts to examine the genesis of this chaos, contrast the present situation with the ideal, and present a reasonable alternative. Such topics as avoidance of jargon, non-numeric computing, rigidity vs flexibility, human engineering of systems, and user-oriented DP departments are covered.

Since the inception of awareness in the human mind, mankind has been a prodigious developer of tools. In fact, the ability to develop and use tools is traditionally considered to be a fundamental factor in determining our humanity. One of the most sophisticated tools developed to date, without a doubt, is the computer.

And yet, we are constantly being bombarded with horror tales about that monster, the computer. Was medieval man more frightened by the demons thought to inhabit the edge of the world? But consider: Did primitive man become less human - or more human - when he discovered that his hunting range could be greatly extended by use of a rounded wooden or stone disc which he called "wheel?"

CHAOS FROM LOGIC

Nowhere have we heard the computer decried as thoroughly as within education. Administrators are overwhelmed; teachers feel their job security threatened; parents see their children becoming a number; students are bewildered. How did we - those of us in educational data processing - manage to create such chaos from a tool supposedly dedicated to logic?

GENESIS

First of all, the typical educational data system has developed haphazardly without a thorough, comprehensive analysis prior to implementation. The educational community has neither the technical expertise nor the money to perform such an analysis. The typical commercial service bureau did not (and still, by and large, does not) understand education. The computer has traditionally come into education in a piecemeal fashion. An ap-

plication is automated when priorities within the district shift to highlight specific problems. Remember the squeaky wheel syndrome?

ENTER THE DP MANAGER

When the information handling situation has reached such a high priority that it is considered fundamental to the functioning of the district, a specialist, the Data Processing Manager, is called in. This individual, often familiar with business applications, rarely has the background in education to effectively rescue things. If the district can afford it, a computer is purchased. If not, they scramble for access to a commercial system. The combination of a resident expert and access to an impressive piece of hardware create a climate of expectation. The requests for services begin to pour in. Lacking a thorough understanding of the needs of education and being basically agreeable, the DP Manager finds it hard to tell anyone "no." Deadlines are set and missed and reset and missed again. Programs do not perform as desired, quite frequently due to faulty communication. The users are intimidated by all the new - and often complex - terminology used by the computer people. The computer people, in turn, develop an attitude of condescension toward those poor dumb beings who think a "byte" is a mouthful of Big Mac.

CONTRAST THIS TYPICAL SITUATION TO THE FOLLOWING IDEAL

A school district, recognizing the burden of clerical manipulation of data for payroll, budget, mark reporting, attendance accounting, scheduling, and

instructional support makes a firm commitment to computing. They wisely decide to remain with their manual systems while performing a thorough study of their needs. They hire an educational consultant with experience in educational administration as well as data processing, systems analysis, and design. This rare individual spends weeks studying how the district does its business. He holds seminars for everyone from attendance clerks to payroll clerks to classroom teachers to the superintendent. He gradually becomes familiar with the district's needs and the district learns what to expect -and what not to expect - from computerization.

After the initiation of both sides, serious discussion begins. Priorities are set. All systems to be automated are rated as to immediacy. Every attempt is made to stage the development.

Meanwhile, the fiscal state of the district is analyzed to determine how many of the identified goals can be accomplished, both in the near future and on a continuing basis. Does the budget permit the acquisition of personnel and hardware sufficient to handle the needs of the district? A timetable is established for the entire project, probably stretching five years into the future. Alternate methods are investigated in an effort to find the most efficient approach.

If the acquisition of hardware appears to be the best solution, staffing needs are then considered. The first staff member hired is the Data Processing Manager, who is given the authority of an Assistant Superintendent. This individual, like the consultant, is thoroughly familiar with both data processing and education. His salary, of course, is equivalent to that which he could earn in industry. The prior analysis allows the district to present its new staff member with an accurate job description and plan for what lies ahead. The DP Manager is allowed to hire his staff without interference, unexpected changes in priorities, or fickle support from the district.

System development then begins according to the schedule of priorities. Primary consideration is given to the human interface, recognizing that the computer exists only to supply school district personnel with timely, accurate, useful information. Each subsystem is carefully analyzed to determine who it is to serve. Each program is written with one goal in mind: Make the system do the work, not the user. Adequate precautions are taken to develop a system that will be considered reliable by its users.

WOULDN'T IT BE NICE?

Realistically, of course, we must

face the fact that most educational users of computing are already somewhere along the way to chaos. One reason seems to be that, while we have all heard the adage "A little knowledge is a dangerous thing," the data processing community rarely considers the impact on the user of having to deal with too much. Quite frequently it is the quantity of data, not its usefulness, that is considered. No one asks the user if he really needs all that information. To be more precise, nobody talks to the user, period - at least not at a level where true communication could occur.

WHAT CAN BE DONE

There are alternatives, however. First of all, the computer center people must realize that the piece of hardware they refer to as "Our Computer" is not theirs at all. It belongs, legally and correctly, to the school system it serves. It does not exist for the programmers' ego gratification. Similarly, the school district administration must realize that the computer does not exist to produce elegant documents to impress the school board. What the computer in an educational data center does exist for is the education of the school system's students. This it can do directly, for example, through CAI or problem solving by students. It can also reduce the burden of manual information handling upon the administrative support staff, freeing them for the necessary human interaction with students, parents, teachers, and administrators.

Secondly, the data center should develop a staff capable of talking to users in their own terms. In particular, it is a wise investment to assign as many staff members as necessary to full-time user liaison. This delicate position requires two capabilities usually considered mutually exclusive: (1) the ability to talk to users in non-technical terms and yet make them comprehend the limitations and the possibilities of the technology, and (2) the ability to talk to the technical staff in the dialect they understand, concisely defining the user's needs.

Program development must be carefully considered. As with any systems analysis project, the end result should be the starting point; first determine exactly what it is the user needs. Quite frequently this requires a great deal of tactful probing by the liaison for often the user is not certain what he does need or how it can be implemented. And rarely will the user volunteer long-range goals that can significantly influence the future use of the system.

Program extensibility and modularity of design are key issues for the technical staff when considering a

system's long-term usefulness. It is very easy, after a few years' operation, to have created a program library monster, containing hundreds of tiny, single-purpose programs and a few very large programs. In either case, program changes, documentation, and job request specification are monstrous tasks. A much more reasonable approach is to create structured programs of moderate size, each program dedicated to a principle or function within the overall system. It then becomes a straightforward matter to maintain, augment, or modify a program. Most programming requests will naturally fall in place if accurate long-range goals were established.

The structure of the data files is also critical. With data base management systems readily available for most computer systems there is little reason to expend the space and time necessary to maintain a multitude of separate files. Program design is also simplified when any program has available all elements of the data record and when one item, such as student name, does not occur in several places.

It should not be forgotten that the computer is not restricted to numeric uses. It is unnecessary and short-sighted to attempt to quantify everything. Upon occasion it is refreshing to see a computer-generated report that does not contain a student ID number. Parents react much more favorably to a communication from the school addressed to "Mr. & Mrs. John Smith" than to something that comes "TO THE PARENTS OF STUDENT 913768." Similarly, with the investment of very little time it is possible to print student names without a multitude of spaces between first and last name, narrative reports rather than page after page of columns, and dates that are decipherable.

There is a precarious balance between rigidity and flexibility. On the one hand, the operations staff must have a sane and orderly structure. On the other hand, why should it be necessary to tell one school building that they must receive their student report cards sorted alphabetically within grade level just because everyone else does? Here again, the liaison staff is invaluable. Parameter specifications can be handled on a personal, non-technical level for the user and yet be precisely coded for operations.

ONE PRACTICAL EXAMPLE

This type of user orientation has been implemented. We at Educational Service Unit #3 in Omaha, Nebraska, have a data processing staff of 18 full-time people serving approximately 50,000 students in 16 independent school dis-

tricts. Our applications are divided into three areas: Student Information Services (master file maintenance, scheduling, mark reporting, and attendance accounting), Business Information Services (budget, payroll, personnel, and inventory), and Instructional Services (problem solving and CAI usage in the classroom). Six of our staff members—one third of the total—are devoted full time to user coordination and liaison. Our approach has included the development of user manuals, simple report specifications, a great variety of options on each report, and a network of user committees to keep us informed of the needs of the districts.

While there undoubtedly are other approaches that provide the user a timely, accurate, useful system, we have found reliance on a strong liaison staff invaluable. In addition, the application of structured programming and the use of data base management techniques have greatly enhanced the continuing effectiveness of the system. Our experience has shown that a humanized data service in education is possible.

Is Anyone Looking: The Effects of Computers on Our Values and Moral Judgments

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West Liberty State College

The results of various surveys concerning the effects of computers on our values and moral judgments will be discussed, along with the implications for those of us associated with computers.

There has been much conversation in recent years concerning the increased computerization of our world. The computer is appearing in more and more places, in our stores, our banks, offices, factories, and even in some of our homes. This increasing application or proliferation, if you choose to call it that, has caused a variety of internal and external reactions in our fellow man (or persons, if you wish). These reactions have, of course, varied from total loathing to intense positivity.

On the other hand, there has been extensive cases of computer fraud and thievery, followed by feverish attempts to improve computer center security. On a lesser scale, many of us may have modified our normal "good guy" approach to our favorite merchants to a more calculated, rational and economic approach. Part of this approach may involve thought processes to the effects, "if the computer makes a mistake in billing me, it's not my responsibility to do a thing about it". If this billing device were instead our local cashier or clerk, might we be more concerned with rectifying the error?

Admittedly, these types of dramatizations are only conjecture and nothing else. What is needed is perhaps a means of quantifying, to some degree, the tendency for events similar to the above to occur. Again, even research into this area is filled with pitfalls as the human subjects of our research perceive our intent or hypothesis. However, except for research into the perfection of a vacuum, something is usually better than nothing.

What was done for our current information was a moderate amount of fact-(opinion, if you will) gathering by the use of a questionnaire. The questionnaire was administered at various times to different groups of students (totalling 137) attending a four year state college in the north-eastern United States. The individuals were primarily in Business and Medical Technology programs, and ranged from the Freshman to the Senior years, with an occasional perennial student (5 or more years of college) thrown in.

Obviously there are limitations to this approach in addition to the geographic monopoly. The fact that the general public probably has a significantly lesser extent of computer exposure is certainly one of the major shortcomings in the particular population used.

It was the author's preconceived notion (although, perhaps, one should not admit to having any) that there exists a noticeable difference in the way that people react to computers as opposed to direct contact with other human beings. The questionnaire was developed with the intention of investigating, and hopefully supporting, this hypothesis.

The survey questions fit into four different groups: questions in which an affirmative answer indicates a positive attitude toward computer applications; questions in which an affirmative response indicates a negative attitude toward computer applications; questions in which an affirmative response is contrary to an honest or 'moral' ethical code; and questions in which an affirmative response is in agreement with an honest or 'moral' ethical code.

On the positive side of the results, the following were noted: 74% of the responders indicated that they always pay their bills on time, whether computerized or not; 71% indicated that they believe that 'moral' issues do have either a clearly right or clearly wrong aspect; 77% considered themselves to be very moral people; 80% indicated a positive response to obedience to the law; 62% would never consider stealing from someone; and only 4% would use someone else's lost credit card.

Concerning attitudes toward the computer in general: 51% prefer to use computer-type forms as opposed to the free hand style; 51% would inform a creditor of inadequate billing; 82% usually have a positive reaction to news or information about computers; 55% are not offended by computer-typed "personal" letters; 65% felt extremely positive about computerized college registration procedures; and 41% even indicated a positive attitude toward a national identity card.

However, on the negative side, we have the following figures: 85% indicated that right and wrong depends only on the situation; 60% indicated that they could get into "closed" classes at registration; 30% indicated that situations exist where it is proper to take something belonging to someone else; 28% have thought about how to get a computer to help them steal.

Also in regard to the computer: only 28% of the respondents would be reluctant to falsify computer-examined personal data; 35% would falsify a computer dating application; 46% are irritated at having their names and addresses sold on mailing lists; and 25% strongly dislike working with forms.

The actual results of interest, though, are the comparisons we can make concerning the potential value structure our systems analysts will have to serve. For instance, while 77% of the respondents considered themselves very moral people, only 42% would notify an employer if overpaid by a computer-generated check, and only 33% would notify a bank if overpaid on interest. Also, 33% of the respondents have considered switching price tags at the store, and 19% state they would have no problem with stealing from a completely automated store.

What we find is a conflict in situations, suggesting that the moral "rightness" or "wrongness" of an act does depend (in the mind of many of the respondents) on whether they are dealing with actual human beings or rather, with machines. This certainly must have implications for the systems developer. Individuals who indicated they would never consider robbing anyone, nor taking what rightfully belongs to another individual, were found to consider accepting gain, which was not rightfully theirs, when the error was made by a computer. It would seem that a computer error would imply no definite victim.

Another interesting highlight is the similarity in responses between advanced data processing students and basic students. The advanced students tended to respond similarly to the other groups for most questions, except in cases where their advanced backgrounds gave them a technical edge.

Although Medical Technology students did not demonstrate a greater number of positive responses toward computers, they did indicate a much lower rate of negative responses toward the machines. Perhaps they are not eager for deeper exposure, and yet more likely to become involved in a computerized situation, such as employment.

Male and female students tend to view the selected choices about the same. The only significant variation is that the female students in upper level data processing and medical technology programs were less likely to give pro-"morality" responses. There is the possibility that their self-concepts were more realistic or mature than their male classmates'.

At this point in our study, we cannot draw any hard and fast conclusions. There is sufficient data for those of us in education and systems-

related areas to realize that we must be more skillful in our security methods. The current state of our social structure does permit an individual to deal with the machine or the corporation as though any loss it sustains is not a loss to real live people. Consequently, these people who are using our systems will not have internalized restraints to prevent such acts.

We must design secure, effective, safe, yet humane systems. This will be a more difficult task as our technology progresses, but will be a worthwhile one in the long run for all concerned.

As implied previously, in the author's experience, this research is barely 'off the ground', but will be expanded to include other institutions, areas, and occupations to provide a more accurate picture of what is going on as our society adapts more and more to the computer. I hope all of us will seek ways to benefit mankind in the long run, and not only today.

SOCIAL IMPLICATIONS OF COMPUTERS: A VISUAL PRESENTATION

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University of Mississippi
Shirley A. Hallblade
University of Mississippi
James Sullivan
Houston Public Schools (MS)

This session takes the form of a narrated slide presentation of some of the societal impacts of computer technology. Following is a preliminary outline of the presentation.

I. Introduction

- A. Computers are an important part of our lives.
- B. Their effects can be both direct and indirect.
- C. Computer technology has important implications for the way an individual is able to live.

II. Individuality

A. Media

- 1. The media are computer-based, made possible by the computer.
- 2. People are shaped by the media, influenced by the media in many ways.
- 3. The media have been accused of creating a homogeneous society, with Americans looking and talking more alike than ever before.
- 4. Is diversity becoming extinct?

B. Choice

- 1. A technological society offers a wider array of choices--career choices, consumer choices, choices in lifestyles.
- 2. But technology also helps us deal with these choices, helping us gather and analyze larger quantities of data. (Example: computerized career counseling).
- 3. The computer helps us make decisions and shape ourselves. (Example:

computer managed instruction).

C. Self-reliance

- 1. Has the complexity of modern life eliminated the self-sufficient individual or family?
- 2. Frontier family vs. modern, technology-dependent family.
- 3. Could we survive if technology were to fail?

D. People

- 1. Because dealing with people en masse is convenient and is now possible, we might see this occurring with more frequency. (Example: public opinion polls and decisions based on their results).
- 2. But computerized manipulation of people and their interests has been described as desirable in some cases, making it possible for individuals with common interests to exchange information and ideas.

III. Automation

A. Jobs

- 1. Computers eliminate some jobs, but create others.
- 2. But the ultimate effect is more people working with machines in one capacity of another.
- 3. Dealing with machines instead of people is often unsatisfactory and dehumanizing.

4. One result of this trend is a shift toward valuing the handmade product, with arts and crafts and "do it yourself" projects becoming more and more popular.
- B. Leisure time--created in part by automation
 1. Some use this time for active participation in activities of choice.
 2. Others have even automated their leisure time activities. (Example: fishing, the lone individual with bamboo pole vs. the bass fisherman with sophisticated boat, gear and even detection devices).
- C. Environment
 1. Because mass production means virtually unlimited output, our mistakes are compounded by large numbers -- cars, aluminum cans, throwaway bottles.

IV. Power

- A. Data banks -- access to them gives the individual power.
- B. Access to the individual's mind: programming behavior; but studying the brain is also leading to understanding mental illness.
- C. Sophisticated weapons--computer-controlled power to eliminate the human race
- D. Computer and false illusion of power. (Example: Social Security number "because computer wants it").
- E. Computerized crime--power to a new kind of criminal.
- F. Opinion polls--expand power to sell products, secure votes.

V. Privacy

- A. Federal agencies collecting data on an individual: IRS, Social Security, FBI, CIA, Census Bureau--computer linkage of government data banks has repeatedly been urged.
- B. In the private sector, to obtain credit, qualify for an insurance policy, secure a loan or join a club or society, computer check might be run on individual's financial dealings, personal habits, credit ratings, military history, education and health records.
- C. Mistakes--human errors compounded; if there is a mistake, what is the individual's recourse?

- D. But, the privacy issue is being considered in the public arena, e.g., Buckley Amendment (privacy act).

VI. Conclusion

The computer itself is neutral--it is an instrument of human beings. Its impact is sometimes good, sometimes bad. The course of history will determine whether or not our use of the first generations of the computer age have contributed to humanity's demise or to its gradual elevation.

THE CERTIFICATION OF COMPUTER PROGRAMMERS

Philip Gensler, CDP
Phillips Petroleum Company
Bartlesville, Oklahoma

William Fly, CDP
The Chilton Corporation
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Certification is being increasingly accepted as a symbol of professional standing in the Computing Profession because of ICCP's efforts on behalf of the CDP program. Now ICCP is planning to institute the CCP, Certificate in Computer Programming, with areas of specialization for Business, Scientific and Systems Programmers. The CCP program may well indicate the development of a hierarchy of certification exams underlying the professional Certificate in Data Processing.

The Institute for Certification of Computer Professionals (ICCP) was formed in 1973 to develop and administer certification and testing programs in the computing industry and to expand into directly related activities as resources permit. The first step for ICCP was to assume the CDP program from DPMA, one of ICCP's eight founding societies. In 1975 ICCP contracted with the Professional Examinations Division of The Psychological Corporation to provide psychometric consultation and services, and also administrative support, for ICCP's testing endeavors.

ICCP, a not-for-profit, non-stock corporation, is governed by a board of directors representing eight data processing societies - the Association for Computing Machinery, the Association of Computer Programmers and Analysts, the Association for Educational Data Systems, Automation One Association, the Canadian Information Processing Society, the Data Processing Management Association, the Computer Society of the Institute of Electrical and Electronics Engineers, and the Society of Certified Data Processors. It maintains regularly staffed offices in Chicago.

In order to assure quality and ever increasing professional status for the CDP program, ICCP appointed the CDP Certification Council, currently chaired by Bill Horn of the Boston College School of Management. The Council, composed of five members, all of whom are CDP holders, is charged with updating the question pool, setting the cut-off scores, adjudicating the Code of Ethics and the related Codes of Conduct and Practice, and determining policies and procedures relative to the administering of the exam. The CDP Certification Council, by utilizing the professional expertise of the Psychological Corporation, has made substantial progress in improving professional acceptance of the CDP program. Enrollment for the 1976 exam was up 18% from 1975 and enrollment for

the 1977 exam is up about 26%. About one third of those who took the 1976 exam were awarded the CDP.

Having been charged with the task of expanding the CDP program into directly related activities as resources permit, ICCP began, about two years ago, to consider reviving the Registered Business Programmer (RBP) exam which it had suspended when it assumed control of DPMA's testing program. About one year ago, Dr. Bill Cotterman, head of the department of CIS at Georgia State University, was appointed chairman of an ad hoc committee to investigate the feasibility of developing senior level programmer certification.

This committee recommended to the board of directors of ICCP that it undertake the establishment of a supplementary testing program, namely the certification of senior level programmers in three areas, Business, Scientific and Systems. At its annual meeting in January 1977, ICCP formed the CCP Certification Council, under the chairmanship of Dr. Cotterman, and charged the Council to establish the Certificate in Computer Programming with three areas of specialization, Business, Scientific and Systems.

As careful analysis of the content outline shown in Exhibit I indicates, these three exams are based upon the concept that there is a body of knowledge which is common to all types of programming. Thus Parts I-V of the outline address this common body of knowledge and represent about 75% of the material on each of the three exams. The other 25%, Part VI, or Part VII or Part VIII, represents the area of specialization.

Parts I-V will not include questions on specific programming languages, as such, although the candidate will be expected to possess a reading knowledge of COBOL, PL/I, FORTRAN and an assembly language, and questions throughout the exam may be presented in terms of these languages. In the areas of specialization, business

programmers will be expected to have a detailed knowledge of COBOL and a reading knowledge of RPG. Scientific programmers will be expected to have a detailed knowledge of FORTRAN. Much debate centered around the merits of a high level language (and which one) versus a machine level language (and which one) for the systems programmer specialization, although it now appears that no detailed knowledge of any language will be tested.

The CCP exams will be oriented toward senior level programmers (five years' experience) although there will be no experience prerequisite for the certification award. The exam will be written at such a level that it should be very difficult for a person to perform well with little or no practical experience.

The first administration of the CCP exam is tentatively set for October 22, 1977, and a question pool is being developed at this time. Since the success of such a certification program could have a profound impact on formal education in computing, AEDS members who are involved in teaching programming, hiring programmers, or supervising programmers are encouraged to take an active part in the development of these exams. One way to be involved is to promote the CCP exam in the member's local computing community.

Another way to be involved in the development of the CCP exams is to contribute to the question pool which is now being established. Questions can be sent to:

ICCP Programmer Examination
304 East 45th Street
New York, NY 10017

They will then be submitted to an item review session and edited for psychometric validity. If possible, a study reference should be included for each question. Also, if sufficient AEDS members are interested in a question generation session at the convention, arrangements will be made.

In conclusion, AEDS members are encouraged to take an active part in the development of the Computing Profession. AEDS, as an organization, does this through its membership in ICCP, but the personal commitment of each AEDS member is urgently needed. Concern for the directions taken by the emerging Computing Profession go hand in hand with efforts to educate and train people preparing for a career in that profession.

EXHIBIT I

Content Outline for Senior Programmer Examination

I. Data and File Organization

- A. Data Formats - Internal and External
 1. Character representation codes
 2. Integer/real representation
 3. Field, record
 4. Conversion

5. Packing/unpacking
6. Parity
- B. Data Structures
 1. Arrays
 2. Stacks, queues
 3. Linked lists
 4. Trees, Plexus
- C. File Structures
 1. Hierarchical/multi-level
 2. Direct/inverted/multi-list
- D. Storage Media
 1. Physical characteristics of primary and secondary storage
 2. Selection considerations
- E. File processing methods
 1. Sequential access
 2. Random access
 3. Index sequential access
 4. Hash-coding/addressing
 5. Sort/search/merge
 6. Table look-up
 7. File updating
 8. Blocking & buffering
 9. File maintenance
 10. File reorganization
 11. File security

II. Principles and Techniques of Programming

- A. Computer instructions
 1. Data input & file instructions
 2. Data transfer & conversion instructions
 3. Arithmetic operations
 4. Decision & logic instructions
 5. Data output & file instructions
- B. Program structures
 1. Sequence
 2. Selection
 3. Iteration
 4. Sub-programs
 - a. Calling routines
 - b. Common area
 - c. Reentrant
 - d. Local/Global variable
 - e. Open & Closed
 - f. Parameter passage
- C. Problem-solving and programming techniques
 1. Development of program logic plan
 - a. Problem definition
 - b. Identification of constraints
 - c. Analysis of problem
 - d. Algorithm design
 2. Representation of program logic plan

flow charts, decision tables, structured programming charts
 3. Initialization routines/end of file routines
 4. Program control
 - a. Sentinel fields
 - b. Program switches
 5. Addressing methods
 - a. Direct
 - b. Indirect
 - c. Relative
 - d. Indexed
 - e. Virtual
 - f. Combined methods
 6. Recursion
 7. Top-down coding
 8. Program style
 - a. Readability
 - b. Ease of maintenance

- c. Ease of use
 - d. Ease of testing
 - 9. Program efficiency
 - 10. Program correctness
 - D. Data and file handling techniques
 - 1. Manipulation of data
 - 2. Summarizing, classifying, selecting, sequencing
 - 3. Field validation
 - a. Check digit calculation
 - b. Limit checks
 - c. Range checks
 - d. Consistency checks
 - 4. File validation
 - a. Hash totals
 - b. Batch totals
 - c. Check sum
 - d. Cross footing
 - e. File label checking
 - 5. File maintenance: insert, delete, change, replace
 - 6. File reorganization
 - E. Program debugging
 - 1. Routines for error handling
 - 2. Routines for check point restarts
 - 3. Test data selection
 - 4. Traces/snapshots/dumps
 - 5. Top-down testing
 - 6. Structured walk-through
- III. Interaction with Hardware and Software
- A. Hardware components
 - 1. Organization
 - 2. Configurations
 - a. Single processor
 - b. Mini-computers
 - c. Multiple processor
 - d. Networks
 - 3. Physical considerations
 - B. Language considerations
 - 1. Assemblers, compilers, interpreters, generators, data base management languages
 - 2. Suitability to problem & programming technique
 - 3. Program linkage and control
 - a. Subroutines
 - b. Program overlays/segmentation
 - c. Linkage editor/collector/allocator
 - C. Utilities
 - 1. Memory & file dumps
 - 2. Sort/merge
 - 3. File backup/restore
 - 4. File catalog maintenance
 - 5. Program library maintenance
 - D. Operating system
 - 1. Input/output processing
 - 2. File system
 - 3. Interrupt processing
 - 4. Task management
 - 5. Program loader
 - 6. Storage management
 - 7. Checkpoint-restart
 - 8. Processing mode
- IV. Interaction with People
- A. User interface
 - 1. Problem analysis
 - 2. Requirement identification
 - 3. Developing program specifications
 - 4. Design of user report forms
 - B. Programmer team relationships
 - 1. Programming standards
 - 2. Testing methodology
 - 3. Project management methods
 - 4. Roles of programmer team members
 - 5. Project control
 - 6. Project planning and estimating
 - 7. Feasibility analysis
 - 8. Cost/benefit analysis
 - C. Documentation
 - 1. Decision tables
 - 2. Flow diagrams
 - 3. Systems charts
 - 4. Program narrative
 - 5. Change control
 - 6. Base line specifications
 - 7. Evaluation of documentation
 - D. Professional ethics and legal consideration
 - 1. Privacy
 - 2. Security
 - 3. Patents, copyrights, trade secrets
 - 4. Personnel practices
 - 5. Contracts
 - 6. Human impact of computers
 - E. Professional development
 - 1. Statistical trends
 - 2. Career paths
 - 3. Continuing education
 - 4. Licensing and certification
 - 5. Professional societies
- V. Associated Techniques
- A. Quantitative techniques
 - 1. Number systems & conversions
 - 2. Accuracy & precision
 - 3. Boolean algebra & logic
 - 4. Matrix algebra
 - 5. Elementary statistics
 - 6. Random number generation
 - B. Systems analysis and design
 - 1. System life cycle
 - 2. Processes of analysis, specification & design
 - 3. Implementation planning
 - 4. Structured design
 - 5. Systems testing
 - 6. Return on investment
 - 7. System simulation
- VI. Specialization - Business Programming
- A. Languages
 - 1. Detailed knowledge of COBOL
 - 2. Conceptual knowledge of RPG-II
 - 3. Structured programming techniques in COBOL
 - B. Accounting
 - 1. Accounting & financial systems structure
 - a. Accounts Receivable
 - b. Accounts Payable
 - c. Payroll
 - d. General Ledger
 - e. Budget
 - f. Inventory
 - g. Cost Accounting
 - h. Cash Flow
 - 2. Fund versus income accounting
 - 3. Accrual
 - 4. Auditing
 - a. Audit trail
 - b. Data controls
 - 5. Financial statements

- C. Data base
 - 1. Architecture
 - a. Hierarchical
 - b. Network
 - c. Relational
 - 2. Management systems
- VII. Specialization - Scientific Programming
 - A. Language
 - 1. Detailed knowledge of FORTRAN
 - 2. Structured programming techniques
 - B. Numerical methods
 - 1. Curve fitting
 - 2. Zeros of functions
 - 3. Interpolation/approximation
 - 4. Systems of equations
 - 5. Eigenvalue/eigenvector
 - 6. Sparse matrix techniques
 - 7. Differential equations
 - 8. Integration
 - 9. Linear programming
 - 10. Optimization techniques
 - 11. Fourier analysis
 - 12. Error analysis
 - C. Applied mathematics
 - 1. Predicate Calculus
 - 2. Combinatorics
 - 3. Statistics
 - 4. Probability
 - 5. Simulation/modeling
- VIII. Specialization - Systems Programming
 - A. Assembler languages concepts
 - B. Operating systems
 - 1. Processor dispatching
 - 2. Interrupt handling
 - 3. Paging supervisor
 - 4. Resource allocation
 - 5. Input/output spooling
 - 6. Operator communication
 - 7. Program loading
 - 8. Memory protection & privileged instructions
 - C. Language processors
 - 1. Language parsing
 - 2. Code generation & optimization
 - 3. Syntactic & semantic analysis
 - 4. Macro & preprocessors
 - 5. Cross compilers, self compilers & compiler generators
 - 6. Module collection & address resolution
 - D. Communication systems
 - 1. Line protocol
 - 2. Multi-tasking
 - 3. Dynamic resource allocation
 - 4. Recovery
 - 5. Distributed processing
 - E. Data management systems

THE COMPUTER IMPACT ON SOCIETY PROJECT

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Report on a project of the Mid-South Association for Educational Data Systems, directed by the authors and funded by the Mississippi Committee for the Humanities. "The Computer Impact on Society Project" was designed as a series of community seminars which focused on issues raised by present and projected use of computer technology. The rationale, goals, design, and implementation of the project are described. Project outcomes are analyzed with implications for further efforts. Additional details about the project will be provided at the convention session, and suggestions for further extensions of this model will be discussed.

Awareness of the need for this project developed out of concerns about our technologically-oriented society and the humanistic issues and value questions raised by these concerns.

Continuous change occurring at an exponential rate characterizes the twentieth century, and at the core of the phenomenon is computer-based technology. Even now the life of virtually every citizen is affected by this technology as the computer makes possible hundreds of services and products which modern society has learned to take for granted. As society becomes even more technologically-dependent, the computer will become an indispensable tool in the daily lives of a major portion of the population. Once a technology has reached this stage, society no longer has the option of accepting or rejecting it. The computer is here to stay; its very existence suggests that it must be dealt with.

Computer technology, however, is not static. It is constantly improving, expanding, and permeating our lives more and more thoroughly. With each advance in the state of computer science come crucial questions and problems. For example, it has been predicted that by 1985 human behavior will be controllable through radio stimulation of the brain. If we can do this, must we? If we do use this technology, should its use be restricted? If so, to what extent and by whom?

While this is a somewhat dramatic illustration, it points out that decisions

about what is technologically feasible need to be made in the context of the social and humanistic implications of the use of such technology. If we fail to confront the problems and decisions of a developing technology, future generations might also suffer. Failing to make decisions intelligently, we will leave behind a less open, less flexible society--one in which later decisions may be too difficult to implement.

Intelligent decisions must be based, first, on an adequate understanding of the applications of computer technology and, second, on a thorough study of technology's implications for current and future generations.

The first consideration requires that citizens perceive the extent to which the computer and its accompanying technology have become a part of their daily lives, balanced with some understanding of what computers can and cannot do. Traditionally, however, few opportunities have existed for the average citizen to obtain understandable information about the nature and scope of scientific developments and implications of technological applications.

The second consideration for intelligent decision-making about computer technology calls for a thorough examination of individual and social values and, in light of these values, a consideration of technology's implications for the future. It is in this area that the perspective offered by the humanist becomes valuable. The concept of the "whole person" has long been a cherished ideal, but in an

age of specialization and fragmentation, today's society may be farther than ever from realizing this humanistic ideal. Insights from the humanistic tradition can help us in our attempt to approach value decisions more intelligently. Perspectives from history, philosophy, religion, and other humanistic disciplines can provide guidance as citizens grapple with questions raised by concerns about life in a technological society.

Awareness of these needs and of the roles which might be played by humanists led the authors to pursue a means by which these issues and questions could be addressed in community settings. Support and funding for this effort was obtained through a \$25,000 grant from the Mississippi Committee for the Humanities, a state-based program of the National Endowment for the Humanities. The Mississippi Committee for the Humanities funds programs which involve scholars in the humanities in meaningful dialogue with the out-of-school adult public on matters of public policy issues which effect a broad spectrum of society.

Within the framework of MCH/NEH guidelines, the authors designed and implemented a project consisting of day-long community seminars on the topic, "Computer Impact on Society." The programs provided opportunities for Mississippi citizens, humanists, and technologists to interact on questions and issues related to this topic.

The Project Model

The over-all goal of the project was to provide an opportunity for Mississippi citizens to become aware of the impacts of computer technology on society and of the value-oriented issues which are relevant for making decisions about present and future life in a technological society. To facilitate the achievement of the overall goals, several specific objectives were delineated and these guided the implementation of the project.

Prior to the community seminars, attention was given to the following planning goals having immediate consequences for implementation: 1) To evaluate and redesign the initially proposed project model; 2) To develop materials reflecting humanistic perspectives on the project topic; 3) To prepare the participants for their roles.

Objectives delineated for implementation at the community seminars were as follows: 1) To promote awareness of the impacts of computer technology and of the underlying humanistic issues; 2) To provide a forum for interaction between university scholars and community decision-makers;

3) To promote in-depth discussion of the issues; 4) To stimulate continued consideration of germane issues.

Long-range goals were related to the impacts upon the audience and scholar-participants beyond their immediate involvement at the seminars. The directors also saw as a goal of the project to extend the impact of these immediate efforts to other audiences.

Target Audience. To accomplish the above goals nine all-day community seminars were held in population centers across the state. Two additional meetings were held in conjunction with the Mississippi Personnel and Guidance Association and the Mid-South Educational Research Association.

The objectives place emphasis on the importance of making decisions and the need for taking steps to establish public policy. It was felt that the community would, therefore, derive the greatest benefit from this program if its leaders and principal policymakers were able to attend. Although community leaders and policymakers constituted the primary target audience for this program, all adults who might be interested were urged to attend.

Scholars. Each of the meetings featured three scholars: two humanists and one technologist. These persons were drawn from the faculties of six universities in the region.

In preparation for his/her interaction, each scholar was asked to write a paper on a topic related to the basic issues of concern in this program. Summaries of these papers were distributed at the meetings. Three scholars participating in each meeting had opportunities to present their ideas in brief, informal responses. In addition, they interacted in general open discussions in which the audience participated.

Community Leaders. To balance the input of the university scholars, two local policymakers from the public and private sectors of each community were asked to participate as panel members. These persons were citizens in positions of leadership in community organizations, educational institutions, local government, business or industry, etc.

Program. Each meeting consisted of a morning and an afternoon session. The first part of the morning session served as a sensitizing or awareness session in which the film "Future Shock" was shown. This film, based on ideas taken from the book of the same name by Alvin Toffler, powerfully illustrates many of the social and personal issues created by the

rate and complexity of technological change. It also emphasizes the pervasive and all-encompassing role of computer technology as a compounding variable. Following the film, opportunity was given to the audience to discuss the humanistic issues raised in the film. After a short break, the scholars shared their reactions/perspectives in a brief informal presentation, and discussion with the audience followed.

The afternoon sessions focused more specifically on the impact of computer-based technology. A slide/tape presentation began the session, illustrating the extent to which computers permeate modern life and focused attention on implications for individuals in both present and future societies.

In this context, the three scholars and the two community leaders/policymakers briefly shared their responses. Again, the humanistic scholars provided perspectives from humanistic orientations as related specifically to ways in which societies and individuals can deal with the impact of computer technology.

Open discussion and interaction followed, culminating in focus on the question "What should/can we do?" Audience and program participants were urged to suggest alternative responses to some of the problems and issues previously focused upon, and to suggest the effects each decision might have on the quality of life of later generations. The programs concluded with a summary and wrap-up session in which basic issues and audience/participant suggestions were reviewed.

At each meeting, participants were given an opportunity to examine a collection of books and articles related to the program's theme. Extra copies of some of these materials were available for purchase before and after meetings. Annotated bibliographies of suggested readings were prepared and these were distributed at each meeting.

Publicity/Promotion. The local libraries or community centers whose facilities were used were asked to cooperate in promoting attendance at the meetings. It was suggested that books in the library's collection related to the program theme be displayed during the week prior to the meeting.

In addition, several community leaders and groups in each city were asked to assist in promoting attendance through word-of-mouth and by distributing posters.

Local newspaper editors were contacted and provided with copy for both feature

articles and brief announcements. Local radio stations were asked to broadcast information during community service announcements, and TV stations were contacted for both interview programs ("talk shows") and news coverage. The programs were also publicized through Mississippi ETV and through selected professional journals.

Evaluation of Outcomes

The full-day session at each seminar included several components. Those aspects highly rated and most often listed as strengths by audiences were the film "Future Shock," the presentations by the scholars and the discussions between scholars and audience. The scholars were seen as "well-informed" and able to "relate their knowledge and views to the group." The quality of the discussions and the level of participation in the dialog were often cited as strong features of the program.

The scholars came to each seminar after having documented their preparation in considering some humanistic issues regarding the computer. The mix of scholars in the program (two humanists and one technologist per session) provided an even-handed opportunity to discuss humanistic issues concerning science and technology in an environment that was not loaded against science--since that discipline was also represented.

The communication barrier that typically exists when professors and community people come in contact was quickly dismantled at these seminars. The security of the professors at the sessions was insured since they had previously provided evidence of their preparation. An informal tone to the project was its hallmark from the very first contact with the scholars. The informality continued and was emphasized in preplanning activities and at the community seminars.

It was considered very important that this project not just lightly gloss over the humanistic issues that are entwined with the computer in our society, but rather, foster discussion which probed as deeply as possible within the constraints of the program. The scholars were primed prior to the sessions because of their advance preparation, so they were ready to go into depth for that reason, in addition to having the professorial trait of plunging deeply into a discussion topic. Learning theory indicates that learning is more likely to take place if the content is vividly presented and the learner has opportunity to be actively involved. The high degree of involvement between the scholars, community panelists, and audience,

was aided by the manageable audiences that attended most of the sessions. A couple of the audiences were too large to effect this level of involvement.

Impact on Community Audiences. The amount of continued thinking about the humanistic issues that the participants of these sessions achieve is contingent upon the degree of involvement that they experienced at the sessions. It is also aided by the materials that were available for them to take home (bibliographies, program, posters, scholars' summaries, books, pamphlets, etc.).

While it is difficult to assess the long-term effects of the project on the community audiences who attended the seminars, there is encouraging evidence to suggest that in many cases people were stimulated to do further thinking on the matters raised and to share these thoughts with others. Both in person and in writing, several persons volunteered comments indicating that the timely nature of the topic and the attention to humanistic concerns in the discussions had opened new areas of consideration for them. One participant said: "The seminar offered food for thought both as a short-term and long-term topic....The questions and opinions presented at the meeting make one aware of the impacts."

Another indicator of the long-term impact on those who attended is the expressed intentions to pursue certain activities or behaviors. One participant reported that the seminar had provided information which could be shared with others in dealing with everyday problems. Another planned to incorporate the topics of "future" and "computer impact" in his teaching of high school science, utilizing ideas gleaned from the seminar.

In addition to the "multiplier effect" from those who did attend the seminars, other factors assisted in extending the project's impact to wider audiences. Media coverage and other publicity prior to scheduled meetings undoubtedly reached many persons at some level of awareness. Televised "talk shows" gave the directors an opportunity to present some of the topics at greater length. In several locations, TV coverage of the seminar and/or interviews provided exposure on evening news broadcasts.

In addition, enthusiastic attention was given one of the seminars by the Memphis affiliate of the National Public Radio network. A major portion of the day's meeting was taped and is being edited for a one-hour program to be broadcast in 1977 as part of a series focusing on community issues.

Other audiences will also be reached as the project model developed for these community seminars is perfected and applied in other locations. Requests for information about the project have been received from colleagues who are interested in pursuing similar projects in their own geographic areas. In addition, the directors have been asked to provide variations on the program for different audiences, including an AEDS workshop in March, 1977.

Impact on Participating Scholars. Valuable opportunities for growth have been provided the several scholars who participated in this project. Each scholar was required to produce a position paper as evidence of having researched and considered some humanistic perspectives of the computer.

Several scholars (especially the humanists) commented on how their research and preparation on the topic had opened new areas for them and generated many thought-provoking issues to which their discipline's content and perspective could bring insight. One scholar stated that he left the seminar "a better-informed person about an increasingly important facet of modern life. If that was a universal experience, then it should have a positive effect on the community and state."

For all participating scholars, the sensitization and involvement through this project is a vital factor in effecting long-term change as the scholars pursue their teaching, research, and writing. Several scholars also indicated that they had been stimulated to pursue dialog with their colleagues about issues raised through their participation in this effort.

Conclusions. In reflecting on the nature and outcomes of this project, the directors feel strongly that a unique, quality program on issues of common concern was presented to the people of Mississippi. The scholars who participated were influential in bringing into focus and interpreting the many humanistic issues raised by applications of scientific knowledge. The interdisciplinary setting and cross-fertilization of traditionally "opposing" disciplines had positive effects upon the scholars and on the seminar program and dialog.

The basic purpose and design of this project has several positive features which merit consideration for further efforts to reach community audiences about the impact of computer technology--and about other timely topics.

AUTHOR INDEX

AUTHOR INDEX

- | | | | |
|--|---------|--|------------------|
| Frank W. Allen
University of Mississippi
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FRI, 8:30 a.m., Room 5 | Pg. 165 | John L. Bristol
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THURS, 11:30 a.m., Room 7 | Pg. 254 |
| Kamala Anandam
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WED, 11:30 a.m., Room 2 | Pg. 103 | Douglas M. Brooks
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WED, 10:30 a.m., Room 2 | Pg. 79 |
| Robin D. Avery
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WED, 12:30 & 1:30 p.m., Room 4 | Pg. 111 | Joe Brown
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FRI, 8:30 a.m., Room 6 | Pg. 240 |
| Lowell N. Ballew
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THURS, 2:30 & 3:30 p.m., Room 6 | Pg. 185 | Brad Burris
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WED, 2:30 p.m., Room 1 | Pg. 235 |
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WED, 9:30 a.m., Room 5 | Pg. 161 |
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FRI, 10:30 a.m., Room 6 | Pg. 258 |
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WED, 10:30 a.m., Room 1
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| Joy Belsky
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THURS, 9:30 a.m., Room 1 | Pg. 30 |
| Walter Block
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Dean D. Crocker Dept. of Public Instruction Grimes State Office Bldg. Des Moines, IA 50319 WED, 8:30 a.m., Room 5	Pg. 138	Glenn B. Harvey De Paul University 25 E. Jackson Chicago, IL 60604 WED, 9:30 a.m., Room 6	Pg. 190
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Lee Droegemueller ISD #196 Rosemount, MN 55068 THUR, 11:30 a.m., Room 7	Pg. 254	John Hilek University of Texas at Arlington 210 W. 6th Arlington, TX 76019 WED, 10:30 a.m., Room 2	Pg. 79
Rod W. Durgin Michigan Dept. of Education P. O. Box 30009 Lansing, MI 48909 THURS, 8:30 a.m., Room 1	Pg. 62	Theresa Housden Educational Administration University of the Pacific Stockton, CA 95204 WED, 8:30 a.m., Room 7	Pg. 144
Judy Edwards NW Regional Education Lab. 710 S.W. 2nd Portland, OR 97204 THURS, 10:30 a.m., Room 1 WED, 8:30 a.m., Room 1	Pg. 55 Pg. 55	Glenn Howze Tuskegee Institute Moton Center for Independent Studies 3508 Science Center Philadelphia, PA 19104 WED, 12:30 p.m., Room 1	Pg. 17
J. E. Eisele Office of Computing Activities University of Georgia Boyd Graduate Studies Bldg. Athens, GA 30602 WED, 9:30 a.m., Room 5	Pg. 161	L. Richard Iwan TEX-SIS Follow-up Tarrant County Jr. College 1312 Electric Service Bldg. Fort Worth, TX 76102 FRI, 8:30 a.m., Room 4	Pg. 261
James C. Emery EDUCOM P. O. Box 364 Princeton, NJ 08540 WED, 10:30 a.m., Room 5	Pg. 156	Edward M. Jackowski Office of Management Information State of New Jersey Department of Education 225 West State Street Trenton, NJ 08625 WED, 9:30 a.m., Room 7	Pg. 202
H. Peter Fingar U.P.M. No. 289 Dhahran, Saudi Arabia THUR, 3:30 p.m., Room 2	Pg. 88	Norman E. Johnson Jackson Municipal Separate School District 662 S. President Street Jackson, MS 39205 THURS, 3:30 p.m., Room 1	Pg. 38
William Fly The Chilton Corporation 2819 N. Fitzhugh Dallas, TX 75204 WED, 2:30 p.m., Room 7	Pg. 302	Barbara Kagen P. O. Box 2414 Honolulu, HI 96804 THURS, 9:30 a.m., Room 4	Pg. 21
Phil Gensler Phillips Petroleum Co. 739 AB Bartlesville, OK 74004 WED, 2:30 p.m., Room 7	Pg. 302	Al Kaled Miami University 52 Hughes Lab Oxford, OH 45056 THURS, 10:30 a.m., Room 5	Pg. 172
Benny L. Gooden Crawford Co. K-II School District Cuba, MO 65453 FRI, 9:30 a.m., Room 6	Pg. 140	Frank L. Kaufman California State University School of Business & Public Admin. 6000 J. Street Sacramento, CA 95819 THURS, 9:30 a.m., Room 2	Pg. 92
Shirley Hallblade University of Mississippi P. O. Box 134 University, MS 38677 THUR, 3:30 p.m., Room 5 WED, 11:30 a.m., Room 7	Pg. 306 Pg. 300		

T. P. Kehler Texas Woman's University Department of Mathematics Denton, TX 76204 FRI, 10:30 a.m., Room 2	Pg. 114	Paul V. Lorton, Jr. University of San Francisco College of Bus. Administration San Francisco, CA 94117 THURS, 8:30 a.m., Room 5	Pg. 129
J. Terence Kelly Miami-Dade Comm. College 11011 S. W. 104 Street Miami, FL 33176 WED, 11:30 a.m., Room 2	Pg. 103	Philip A. Mackey Delaware Tech. & Comm. Col. 333 Shipley Street Wilm, DE 19801 THURS, 2:30 p.m., Room 5	Pg. 171
Eugene Kerr Control Data Education Co. LB #66, Suite 423 7839 Churchill Way Dallas, TX 75251 FRI, 8:30 a.m., Room 1	Pg. 26	Spencer E. Martin Ottawa University 10th & Cedar Streets Ottawa, KS 66067 FRI, 10:30 a.m., Room 5	Pg. 283
D. Thomas King St. Paul Public Schools 360 Colborne St. Paul, MN 55102 THURS, 10:30, Room 7	Pg. 244	Walter Mathews University of Mississippi P. O. Box 134 University, MS 38677 WED, 11:30 a.m., Room 7 THUR, 3:30 p.m., Room 5	Pg. 300 Pg. 306
Linda A. Kobylarz Time Share Corporation 630 Oakwood Avenue West Hartford, CT 06110 THURS, 1:30 p.m., Room 1	Pg. 59	Herbert C. Mayer, Jr. The University of Texas at El Paso College of Bus. Admin. El Paso, TX 79968 THURS, 11:30 a.m., Room 5	Pg. 176
Helen T. Kock Minn. Educational Computing Consortium 2520 Broadway Drive St. Paul, MN 55113 THURS, 10:30 a.m., Room 2	Pg. 84	Patricia Mayer East Texas State University Computer Science Department Commerce, TX 75428 WED, 1:30 p.m., Room 2	Pg. 76
Edward S. Kominski Center for Evaluation & Research Rhode Island College Providence, RI 02908 WED, 1:30 p.m., Room 1	Pg. 11	Robert W. McCarley Jackson Municipal Separate School District 662 S. President Street Jackson, MS 39205 THURS, 3:30 p.m., Room 1	Pg. 38
J. J. Lagowski Professor of Chemistry University of Texas Austin, Texas 78705 THURS, 2:30 & 3:30 p.m., Room 6	Pg. 185	Paul E. McClendon Univ. of South Florida FAO 247 4202 Fowler Avenue Tampa, FL 33620 WED, 9:30 a.m., Room 1	Pg. 66
Roger Lambert Wisconsin Vocational Studies Center Univ. of Wisconsin Madison, WI 53706 THURS, 2:30 p.m., Room 1	Pg. 69	George McCollough Texas Education Agency 201 E. 11th Street Austin, TX 78701 WED, 10:30 a.m., Room 6	Pg. 216
Dean C. Larsen Jefferson County Public Schools 809 Quail Street Lakewood, CO 80215 WED, 10:30 a.m., Room 1	Pg. 47	D. A. McKreig Brandon University Brandon, Manitoba, Canada WED, 11:30 a.m., Room 5	Pg. 126
Michael A. Lorber Illinois State University Normal, IL 61761 THURS, 11:30 a.m., Room 2	Pg. 116	LuAnn McMahon Lab. for Statistical & Policy Research McGuinn 508, Boston College Chestnut, MA 02167 THURS, 1:30 p.m., Room 7	Pg. 287

G. E. McMaster Brandon University Department of Mathematics Brandon, Manitoba, Canada WED, 11:30 a.m., Room 5	Pg. 126	Norman R. Nielsen Stanford Research Institute Princeton, NJ 08540 WED, 10:30 a.m., Room 5	Pg. 156
M. J. McReynolds Charleston County School Dist. 3 Chisolm Street Charleston, SC 29401 FRI, 9:30 a.m., Room 1	Pg. 7	Beverly O'Neal EDUCOM P. O. Box 364 Princeton, NJ 08540 WED, 10:30 a.m., Room 5	Pg. 156
Jack Merrill Computer Division Memphis City Schools 2597 Avery Memphis, TN 38112 WED, 1:30 p.m., Room 6	Pg. 276	Francis S. Pinkowski State of New Jersey Dept. of Education 225 West State Street Trenton, NJ 08625 WED, 9:30 a.m., Room 7	Pg. 202
Donna C. Mertens Nat. Center for Educa. Stat. 400 Maryland Ave. SW Room 3033 Washington, DC 20202 THURS, 8:30 a.m., Room 7	Pg. 213	Stanley Pogrow Univ. of Illinois Room 333, College of Educ. Urbana, IL 61801 THURS, 2:30 p.m., Room 2	Pg. 122
Kenneth L. Modesitt Dept. of Mathematical Sciences Indiana Univ. - Purdue Univ. Ft. Wayne, IN 46805 FRI, 9:30 a.m., Room 2	Pg. 80	Taylor Pohlman Region 10 Education Service Center 400 E. Spring Valley Road Richardson, TX 75080 THURS, 1:30 p.m., Room 1	Pg. 59
Lawrence J. Molloy Michigan Dept. of Education P. O. Box 30009 Lansing, MI 48909 THURS, 8:30 a.m., Room 1	Pg. 62	Ronald G. Ragsdale The Ontario Institute for Studies in Educ. MECA Department 252 Bloor Street West Toronto, Ontario M5S 1V6 FRI, 8:30 a.m., Room 2	Pg. 100
Edgar N. Morgan Texas Education Agency 201 E. 11th Street Austin, TX 78701 FRI, 8:30 a.m., Room 6	Pg. 240	S. M. Raucher IBM Corporation 10401 Fernwood Road Bethesda, MD 20034 THURS, 9:30 a.m., Room 6	Pg. 208
Kathy Moroney Child Development Information Retrieval System Office of Child Development State Dept. of Education 721 Capitol Mall Sacramento, CA 95814 WED, 8:30 a.m., Room 7	Pg. 144	Linda Lea L. Ray 21320 Oldgate Road Elkhorn, NE 68022 THURS, 10:30 a.m., Room 4	Pg. 295
Eugene J. Muscat EDP Resource Center San Francisco Unified S.D. 400 Mansell San Francisco, CA 94134 THURS, 8:30 a.m., Room 5	Pg. 129	S. Reisman IBM Canada Laboratory 1150 Eglinton Avenue E. Department 823 Don Mills, Ontario, Canada M3C 1H7 WED, 2:30 p.m., Room 2	Pg. 96
James W. Nash Wayne County Intermediate S.D. 33500 Van Born Road Wayne, MI 48184 WED, 12:30 p.m., Room 6	Pg. 251	Don R. Roberson Texas Education Agency Common Core of Data Project 1011 San Jacinto Street #103 Austin, TX 78701 THURS, 10:30 a.m., Room 6	Pg. 194
H. P. Nicely, Jr. Miami-Dade Community College 11011 S.W. 104 Street Miami, FL 33176 FRI, 9:30 a.m., Room 4	Pg. 265	Robert Rogan West Liberty State College Box 87 West Liberty, WV 26074 FRI, 10:30 a.m., Room 7	Pg. 298

Donald R. Scherer Box 118 Caldwell, CUA Washington, DC 20064 THURS, 1:30 p.m., Room 6	Pg. 279	James Sullivan Houston Separate School Dist. Houston, MS 38851 WED, 11:30 a.m., Room 7	Pg. 300
Donald D. Scriven Northern Illinois Univ. 543 Lucinda Avenue DeKalb, IL 60115 WED, 1:30 p.m., Room 7	Pg. 291	David Swanzy Meadows School of the Arts Southern Methodist Univ. Dallas, TX 75275 FRI, 9:30 a.m., Room 7	Pg. 272
Ronald Segal EDUCOM P. O. Box 364 Princeton, NJ 08540 WED, 10:30 a.m., Room 5	Pg. 156	Ralph Teter Region 4 Education Service Center P. O. Box 863 Houston, TX 77001 WED, 2:30 p.m., Room 5	Pg. 133
James R. Sherman Educational Management Services, Inc. 4510 W. 77th St. Suite 150 Minneapolis, MN 55435 THURS, 12:30 p.m., Room 6	Pg. 222	C. Ray Thomas Texas Education Agency Common Core of Data Project 1011 San Jacinto Street #103 Austin, TX 78701 THURS, 10:30 a.m., Room 6	Pg. 194
Steven J. Skinner Illinois State University DeGarmo Hall 525 Normal, IL 61761 THURS, 11:30 a.m., Room 2	Pg. 116	J. Richard Walker Memphis City Schools 2597 Avery Memphis, TN 38112 WED, 1:30 p.m., Room 6	Pg. 276
Larry R. Smith Wayne County ISD 33500 Van Born Wayne, MI 48184 THURS, 1:30 p.m., Room 5	Pg. 148	Steven F. Watts South Carolina Dept. of Education Charleston, SC 29201 FRI, 9:30 a.m., Room 1	Pg. 7
Mark Smith Worcester Polytechnic Institute Worcester, MA 01609 FRI, 10:30 a.m., Room 1	Pg. 41	Robert F. Wegener Denver Public Schools EMIS Room 220 900 Grant Street Denver, CO 80235 WED, 2:30 p.m., Room 6	Pg. 197
William C. Smith Texas Woman's University Box 22865, TWU Station Denton, TX 76204 THURS, 9:30 a.m., Room 5	Pg. 181	Robert .. Williams St. John's University Grand Central & Utopia Parkways Jamaica, NY 11439 THURS, 1:30 p.m., Room 4	Pg. 107
Norman E. Sondak Worcester Polytechnic Institute Worcester, MA 01609 FRI, 10:30 a.m., Room 1	Pg. 41	Robert B. Wright, Jr. Texas Education Agency 201 E. 11th Street Austin, TX 78701 WED, 10:30 a.m., Room 4	Pg. 1
Dennis H. Sorge Purdue University Math Building West Lafayette, IN 47907 THURS, 2:30 p.m., Room 7	Pg. 228	June Yamashita Kailua High School 451 Ulumanu Drive Kailua, HI 96734 THURS, 9:30 a.m., Room 4	Pg. 21
Dennis W. Spuck University of Houston AED-Farish Hall 4800 Calhoun Houston, TX 77004 THURS, 12:30 p.m., Room 1	Pg. 32	S. James Zafirau St. John's University 61 Leslie Lane New Hyde Park, NY 11040 WED, 2:30 p.m., Room 4	Pg. 50
Pat Sturdivant Region 4 Education Service Center P. O. Box 863 Houston, TX 77001 THURS, 8:30 a.m., Room 4	Pg. 15		

ADDITIONAL PAPERS

PLANNING ACADEMIC COMPUTING

D. F. Costello
University of Nebraska

The recent efforts of a mid-western university in planning of computing activities in the academic environment is described. Innovations included are long-range planning as opposed to the usual emphasis on short-range planning and a modification of the Delphi approach in the actual planning effort. Some of the competing perspectives facing those who are concerned with academic computing are exposed and clarified.

It is fashionable today to hold to the superstition that we are carried into the future by the uncontrolled winds of technological change. Computing, in particular computing in higher education, justifies some of this pessimism. There are, however, exceptions. A mid-western university, conscious of itself as a citadel of intellectual activity in the region, commissioned the effort which we are reporting in this paper. It asked for a study which would provide a sense of direction to computing activities in the academic environment of the University of Nebraska system in the period of 1978-1983. A new sense of direction was needed since, as with many universities, recent activities in this area were restricted to short term linear steps made in response to changes in environment. It was felt that it was time to step back and take a long look.

Through its three functions - education, research, and service - the university is deeply affected by many pressures for change. Being able to not only live with and absorb these changes, but also to anticipate them and make use of them requires a new sense of purpose, a new perspective on planning.

Some would say that computer and information processing are by the very nature of their novelty a poor choice of an area in which to begin long-range planning in academic administration. Many will complain that the percentage of the faculty and students who are enfranchised at

satisfactory levels of information is too low to obtain any meaningful direction. Others will claim, as one physicist recently put it,

"More often than not, the marketplace doesn't know what it can aspire to until technology points the way."

This group believes the technology we need is here; we need merely get on with the work. Some wish to have no plan, and there are even those who are convinced that a plan has already been developed. Some or all of the above objections may prove to have been valid as the planning turns into action.

The community at Nebraska recognized the large investment that had been made, not only by the computing establishment in hardware and software, but also the tremendous investment by the faculty and students themselves as they develop ever more sophisticated software systems. The University of Nebraska, like many of our land grant colleges, is no longer equipped with the budgets required to do basic research concerning the role that computers should play in the academic process. The investment that has already been made must be protected while future investments of time, money and people must be wisely cultivated. Neither had Nebraska developed a reputation of being in the forefront of information processing advances. Thus, it has not and as of yet cannot take advantage of the rich get richer syndrome that characterizes much of the federal funding process.

During the period 1970-1976, the faculty and staff of the University of Nebraska monitored the costly efforts being expended in sophisticated state and national computing networks. They were familiar with the contents and optimistic projections of the Pierce Report¹ as well as the report of the Carnegie Commission on Higher Education². They were aware of Anastasio and Morgan's³ warnings on those factors that inhibit the use of computers in instruction. However, they had their own problems to contend with.

Beginning in 1970, University-wide efforts to combine and conserve computing power found much of Nebraska's efforts directed at combining research, teaching and administrative data processing in one rather small network supporting these functions at the University of Nebraska-Lincoln, the University of Nebraska at Omaha and the University of Nebraska Medical Center.

The time spent in consolidating these efforts left little time and manpower to develop academic computing. However, at Nebraska, like other institutions, "the economic conditions during the last three years have actually turned the support of academic computing by institutions away from a promotive stance to a positive force of inhibition."⁴ At first glance, it appears that this put Nebraska further behind the rest of the country. On further examination, Nebraska may find that they have been rather fortuitous, as many of the academic networks founded in this period proved to be both expensive and ill-conceived. For example,

"In 1974, less than 10 of the original 33 'instructional networks' remained in existence. Earlier in 1974, it was becoming painfully obvious that the purchasing of machines, even with emphasis on instructional usage, was an incomplete concept to affect curriculum reform via the computer."⁴

Nebraska watched the developments of PLATO and TICCIT, those of EDUCOW and EIN, and the work of CONDUIT and other less publicized efforts. Each and every one of these seemed to be an "incomplete concept." No delusions were held that some splash of genius would lead us to a "complete concept." Rather, we proceeded by taking advantage of the mistakes of the past and the advice of those who have been down those paths to secure a direction that is in harmony with University of Nebraska goals and enjoys some degree of consensus from the

faculty that make up this University.

The Academic Computing Services planning efforts began in December, 1975, at a series of information meetings between the Computer Network and the Chief Academic Officers of the University academic administration.

In these early meetings it was recognized that a good deal of University-wide thought had already been given the Hospital Information System and the Administrative Data Processing system of the University. It was clear that both of these efforts would consume a good deal of the available computing resources and that if care were not taken, academic computing might not receive its fair share.

Before planning had gone very far, Nebraska looked at what other universities were doing in academic computer planning. It appeared that the planning efforts of most computing facilities were concentrated in hardware planning. This was either done by the computing facility staff or by the university's computer advisory group. Mossman surveyed a number of statewide computer planning documents,⁵ but these seemed to miss the necessary ingredients referred to by Denk. The University of London had completed a 1975 planning document⁶ concerning the role of computers in that University. London used the technique of commissioning position papers from recognized authorities concerning the future role of computers in specific disciplines. The disciplines were chosen because of the high impact computers already had and presumably would have on those disciplines. This approach appealed to us. This technique of choosing expert insight to mold opinion and influence decision-making is not new. In a more general format, this tool is used in technological forecasting and is known as the Delphic Oracle approach, or, briefly, as the Delphi method.⁹ The technique is imaginative in that respected peers project the future as they see it, and by iterative questioning, revise their estimates of the future based on feedback concerning their colleagues' opinions. One of the disadvantages in using experts has been found to be the fact that these specialists seem generally optimistic about the short-term and pessimistic where the long-term future is concerned.

In any planning situation, especially concerning computing, there is the tendency for the interested parties to dictate and overwhelm those who are less interested or knowledgeable about the planning subject. It was hoped that this Delphi technique would be less threatening and more cooperative.

The University of Nebraska Academic Computing plans not only needed the support of the Office of Academic Affairs but also the support of the operating academic officers of the institution, namely, the Deans and Department Chairmen. These people were in line positions, both responsible and aware of the many competing priorities for teaching and research in the disciplines under their jurisdiction. We felt that they would know better than anyone else the strengths and weaknesses of their disciplines and the potential importance and value that computers might play in the teaching, research and public sectors of their disciplines.

During the past 25 years, first salesmen, then computing center directors, then faculty computing groups each in turn advised and led universities in the direction each thought computing should take at a particular point in time. This planning was based on the premise that the academic user community has developed enough computer sophistication that they themselves can delineate and influence the kinds of computing services they will need in the 80's.

It was also believed that the Delphi technique is valuable in updating people's perspectives about the future. In particular, it was felt that computers were playing an increasingly important role in education and that almost every discipline could be affected by different aspects of using the computer as an instructional delivery tool. Furthermore, it was believed that the Deans and their advisors would welcome periodic updating on the potential impact of this major facet of educational technology. It was decided, therefore, that planning would focus on those who were most likely to be the agents of change in the academic curriculum, namely, the Deans of the 22 member Colleges of the University of Nebraska and the departments under their jurisdiction. It was also agreed that a secondary purpose of the planning effort would be to continually update the Deans and their advisors on potential uses of the computer.

The Nebraska modification to the Delphi technique included letting the Deans, though themselves certainly not experts in computing, project the future as experts in education. When the survey was completed the summarized material was returned to the Deans with a request that they review the material and compare their response to the University-wide perspective.

By this method three things were achieved:

1. There was a more accurate sizing of when and what computing services were perceived as needed by the University.
2. The community was informed of the current state of computing in academia as perceived by the Academic Officers of the institution.
3. The agents of change were alerted to the potential ramifications of including or excluding computers in their planning.

The first step in this plan was the convening of a University-wide conference entitled "Computers and Academia." Just prior to the conference the President of the University communicated in writing to each of the campus Chancellors, commissioning them to appoint a member of their campus staff to a University-wide Academic Computing Task Force and advising them of the upcoming conference on "Computers in Academia." The President sought their support for attendance at the conference and for the contribution they could make in the planning effort. Since the Deans recognized the possibility of erosion of support for computing in academia and that this was a potential threat to programs on their campuses, they for the most part enthusiastically lent their support to this effort.

During the course of the study an item emerged that may be considered the hidden agenda item in this effort. Activity in the development of courseware has led to the emergence of "value" being associated with this new form of intellectual property being generated by the academic community. It was decided to investigate the situation and develop a position paper concerning the relative rights and privileges of faculty, staff, University and the vendors to the property developed in an academic computing environment.⁸

Figures I, II, III and IV highlight some of the results obtained from summarizing the Dean's and Department Chairmen's perspectives on the future. A more detailed description of these findings are reported elsewhere.⁹

The study is a continuing one in that an effort is being made to ascertain

similar and related opinions from recent graduates of the University, local interested industry, and national experts. This information will then be summarized and also returned to the Deans and Department Chairmen.

It is hoped that this effort will expose and clarify some of the competing perspectives facing those who are concerned with academic computing. We have come a long way in academic computing in the last ten years. There are new hardware directions which challenge the planning sensibilities of the centralist and decentralist alike. There are new software directions which should challenge anyone interested in planning and managing this new variety of intellectual property. But the problems of planning the development of the intersection of computing with academia involve even more complex issues. They are no less complex than the issues concerning higher education itself. The competing priorities are really there and they are perceived differently by the different principals involved.

Figure 1

(1.B) Computer Testing (Compt.Tst.)

DEFINITION: The use of the computer to store large item banks of objectively scored items which are organized in a way that permits easy, effective and efficient test construction and/or grading.

QUESTION: By what year do you expect this service to be of value to the departments under your jurisdiction?

RESULTS:

	Lower Quartile	Median	Upper Quartile
UNO	1977	1980	1984
UNMC	1977	1980	1980
UN-L	1978	1980	2000
U -Wide	1977	1980	1986

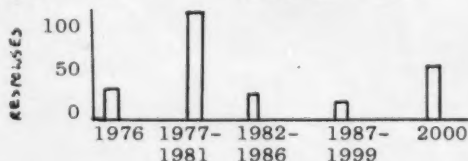
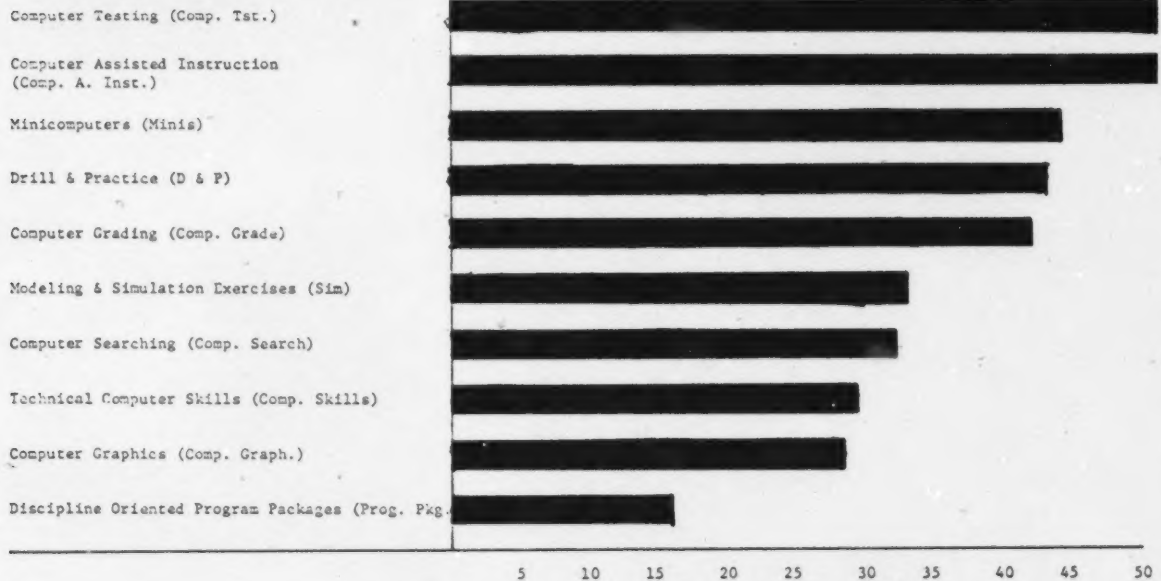


Figure II

University-wide Computer Services Ranked by Relative Value (1980)

By what year do you expect this service to be of value to the departments under your jurisdiction?



NUMBER OF RESPONSES (374)

Note: Total number of responses for all years was 1892.

Figure III

QUESTION: Do you believe your graduates are currently graduating with an acceptable proficiency level in computing?

RESULTS:

	Yes	No	Other
UNO	6	31	2
UNMC	8	41	1
UN-L	19	40	11
Total	33	112	14

Figure IV

QUESTION: Do you believe the computer can help improve academic productivity?

RESULTS:

	Yes	No	Other
UNO	41	0	0
UNMC	48	1	0
UN-L	57	9	4
Total	146	10	4

References

1. Pierce Report: "Computers in Undergraduate Education: Mathematics, Physics, Statistics and Chemistry", University of Maryland, 1967.
2. Carnegie Commission on Higher Education: "The Revolution Instructional Technology in Higher Education - A Report and Recommendations", McGraw Hill, 1972.
3. Anastasio, E. J. and Morgan, J. S. "Factors Inhibiting the Use of Computers in Instruction", EDUCOM, 1972.
4. Denk, Joseph R. "Instructional Computing Support for Higher Education", Conference on "Computer Applications in Instruction for College and University Executives", 1976.
5. Mossman, Charles. "Statewide Computer Systems - Coordinated Academic Computer Planning", Macel Dekker, Incl., N.Y., 1974.
6. Anon. "ULOC Services 1977 - Planning Studies", University of London Computer Centre, 1975.
7. Jantsch, Eric. "Technological Planning and Social Futures", Cassell & Co., Ltd., 1972.
8. Costello, Donald F. "Computer Software in Education: Property Rights, Use, Royalties", Second Annual Conference on Academic Planning, USC, 1977.
9. Costello, Donald F. "Planning Academic Computer Services - A Delphi Approach", Fourth Annual ACM SIGUCC Symposium, St. Louis, Missouri, 1977.